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Frank Thompson D.S.O.
1922.

NOTHING is more worthless than an incorrect diagnosis, and no matter how well the wrong treatment is applied, it remains the wrong treatment. First of all, then, make a correct diagnosis.

H. R. R.

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ELECTRO-RADIOGRAPHIC DIAGNOSIS

ELECTRO-RADIOGRAPHIC DIAGNOSIS

A Book on the Electric Test for Pulp Vitality, Giving the Technic of Its Use in Detail and Submitting Clinical Evidence of Its Absolute Necessity to Dental Diagnosis

BY

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WITH 135 ILLUSTRATIONS

LONDON
HENRY KIMPTON
1921

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TO
MY IDEAL
OF A MOTHER
THAT IS
TO
MY MOTHER

PREFACE

The object of this little book is to help bring the electric test for pulp vitality into its deserved popularity and the writer hopes to accomplish this by doing two things: (1) By showing how frequently the test is necessary to correct dental diagnosis and (2) by teaching in detail the technic of its application.

Every dentist who has an x-ray machine, and every dentist who does not have an x-ray machine, should use the electric test for pulp vitality. In short the electric test is of the utmost value to any one who attempts dental diagnosis. It is often absolutely indispensable to correct diagnosis, of which fact the reader will be convinced, I believe, by reading Chapters X and XI.

The writer has had most of the notes used in the writing of this little book in his possession since 1916, at that time, I dare say, there were not fifty dentists in the United States using the test. In the past four years the test has commenced to receive a wider recognition. But even yet only a comparatively few dentists use it. The reasons for this, it seems to me are: First, the value and importance of the test are not fully appreciated. Second, the necessity of acquiring knowledge of correct technic is not appreciated. Third, the dental electrodes in use are inadequate. Let us consider each of the foregoing.

First, the value and importance of the test: I believe I am right in saying that, with a few exceptions, the only men to have a really comprehensive idea of the importance of the electric test as a diagnostic measure are a few radiodontists. The electric test for pulp vitality is one of those things which, being *well known of, is little known about.*

Second, the necessity of acquiring knowledge of correct technic: Dentists seem actually to consider it beneath their dignity to try to learn how to apply the electric test well. They say, "Why all there is to it is to touch the tooth, and if it hurts it is alive, and if it doesn't it is dead. Isn't that right?"

I believe it requires more skill and judgment to apply the electric test correctly than to make photographically good radiographs. (Please note that I say "photographically good radiographs." Do not misunderstand me to mean a good radiographic diagnosis.)

The present attitude towards the electric test (and the radiograph, too, for that matter) reminds me of the history of amalgam, vulcanized rubber plates, and the inlay.

When amalgam was first introduced the curbstone description of the technic for using it ran something like this: "You simply take some filings in your hand, add a few drops of mercury, and rub them together with your thumb. The stuff gets like putty, and you daub it into the cavity."

When rubber for plates was discovered it made denture making so easy a halfwit could do it—or did it?

When the inlay appeared, all there was to it was to "punch a little soft wax into the cavity, have the patient bite, trim off the excess, pull it out, and dismiss the patient." The next day the patient came back and the inlay was slipped into place(??).

Time has caused us to alter our opinion of these things. But we are going right ahead, making the same mistakes about the simplicity of making radiographs and the simplicity of applying the electric test for pulp vitality. The truth of the matter is, or so it seems to me, that it is extremely easy to do a thing badly but hardly ever easy to do it well.

There are details about the technic of doing most anything which must be learned by personal experience.

However, the personal experience of another may make your task of developing technic much easier. My personal experience in the application of the electric test has been rather extensive. I have traveled from the point where I considered the use of the test absurdly simple to the point where I know it is not so simple as it looks, at first sight. I hope I blaze the trail and make the going a bit easier for those who read this little monograph.

Third, the dental electrodes in use are inadequate: It is little wonder that the test is not more popular, and that some men have started to use it, only to discard it. Most of the dental electrodes I have seen in use are such as to render the correct application of the test either extremely difficult or absolutely impossible. In this connection I may say that I have never known any one, who has taken the time to *master* the technic, to discontinue the use of the test.

Though I find myself in rather extensive disagreement with what he has written, I want to direct attention to the fact that the first man to have even an inkling of the real importance and size of the subject of electro-diagnosis of pulp vitality was Dr. Herman Prinz. Dr. Prinz, years ago, devoted a chapter of several pages to the subject in his book on therapeutics. Upon reading it at the time I recall my tendency to ridicule Dr. Prinz's efforts and to accuse him, in my mind, of having an inordinate lot to say about a subject, which, as I thought then, should have been covered in a few paragraphs. In making this admission I automatically apologize to Dr. Prinz, and give him credit for his foresight.

Now I find myself writing a whole book on the subject! I have tried to make the book as short as possible and still have it cover the subject in a thorough manner. Read it, and see whether you do not come to the same conclusion I have finally reached, which is, simply that *the subject is*

a bigger one than we gave it credit for being. I direct your attention to the fact that, in order to keep the book as small as possible, I have included no history, neither have I been able on this account—the effort to keep the book small—to include anything even remotely approaching a detailed electrical description of the various types of pulp testing machines.

To the beginner, particularly, I would say one should not attempt to ingest, digest, and assimilate the subject at one sitting. Don't *study* it, just *read* the book from beginning to end. Then commence the work, and *study* the book by referring to it as you progress with the work.

If after starting to use the electric test you are about to discard it, I earnestly advise you not to. Try again, for, like the radiograph, the electric test for pulp vitality is with us to stay. Electro-determination of pulp vitality is as essential to dental diagnosis as airplanes are to modern warfare.

Even after an author has seen good proofs, and therefore knows that good halftone plates have been made for his radiographic illustrations, he cannot be sure that the ink pictures will appear in his book or his magazine article as they appeared in the proof. What the printer will do to one's illustration, as this last step in their making is taken, is a matter of great uncertainty.

I have done more retouching in this work than I have ever done before. Even so, I have not done a great deal. When my first work on Radiodontia was printed I did not dare do much retouching. My readers would not have accepted my radiographs as true had I done so. Today, however, the profession as a whole has become sufficiently familiar with x-ray findings so that an author need not be so careful to protect himself against unjustifiable incredulity.

The blacks and whites of "negative halftone" illustrations are the same as in the original negative. The blacks and whites of "print halftone" illustrations are the same as in a photographic print made from the original negative. Both have their advantages and disadvantages. The "print halftone" can be made to carry *more detail* but the "negative halftone" looks better and can be retouched to better advantage.

Of course it is impossible to know what the future holds. The electric test for pulp vitality has sufficient virtues so that it should become popular, but there are some things that react against it. All of the many details necessary to its really intelligent use are set forth in Chapters V, VI, VII and VIII, for example. But then there is this to be said: Like the amalgam filling and the radiograph, it may be used in a very inadept manner and still *some* good results will accrue.

Men who find dental x-ray diagnosis very easy will not welcome the idea that pulp testing is necessary, for it will make their work harder for them. But men whose ambition it is to make a correct diagnosis even if it does require work will welcome the test.

The "Analysis of the Book for the Benefit of the Busy Reader" will, I hope, meet with the approval of "the Busy Reader." The effort is something of an innovation, as far as I know. It is prompted by a desire to do unto my reader as I would wish to be done by.

I am glad to show my appreciation, by acknowledging my indebtedness and offering my formal thanks to Mrs. H. R. R., who has done most of the literary work (including the exasperating task of proof reading) which lies between the first "dirty copy" and the finished book.

H. R. R.

Albuquerque and Indianapolis.

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ANALYSIS OF THE BOOK FOR THE BENEFIT OF THE BUSY READER

CHAPTER I

By Way of a Beginning

A short chapter in which the writer sets forth some of his views regarding the electric test for pulp vitality. Of passing interest.

CHAPTER II

Pulp Testing Machines

In which the various types of pulp testing machines are mentioned and their relative advantages and disadvantages discussed. Not much said about electric construction.

CHAPTER III

Requisites of a Pulp Testing Outfit

In which the requisites of a pulp testing outfit are enumerated and discussed. Special emphasis being laid on the necessity of using the right kind of a dental electrode.

CHAPTER IV

Fundamentals in the Technic of Applying The Electric Test for Pulp Vitality

Only the barest fundamentals in the technic of applying the electric test for pulp vitality are set forth in this chapter. The operator must have the knowledge set forth in this chapter or he cannot apply the test at all.

CHAPTER V

Special Points in Technic

Wherein special points in technic are described. This is a very important chapter. The operator need have only the information set forth in Chapter IV to apply the test, but if he would apply it well, he must master the special points in technic set forth in this chapter.

CHAPTER VI

Things Which Modify the Strength of Current Necessary to Test Teeth

Like Chapter V, this is an important chapter. The information it gives is necessary to an intelligent use of the test.

CHAPTER VII

Limitations of the Test

All tests, no matter how good, have limitations, and it is as necessary to know the limitations of a test as well as the possibilities, and so guard against disappointment and error.

CHAPTER VIII

Applying the Test for Nervous Patients

A sort of verbal clinic in which the writer attempts to describe in detail how he handles nervous patients.

CHAPTER IX

Answering Adverse Criticism

Not a great deal has been written about the electric test for pulp vitality but that which has appeared seems to have been either definitely laudatory or definitely derogatory. The writer has already discussed the limitations of the test and here answers criticisms which seem to him unjust.

CHAPTER X

Clinical Value of the Test

A chapter to be browsed over. An effort to indicate the clinical value of the test verbally.

CHAPTER XI

The Test As An Aid in the Interpretation of Radiographs

(Cases from Practice)

An effort to prove the value of the test by submitting considerable radiographic evidence of its necessity to the correct interpretation of radiographs. Perhaps the most important chapter in the book.

ELECTRO-RADIOGRAPHIC DIAGNOSIS

CHAPTER I

BY WAY OF A BEGINNING

There is no incentive to study the always more or less dull subject of technic unless one is aware of the benefits to be derived. So, my reader, if you are not already cognizant of the importance of the electric test for pulp vitality as a diagnostic measure, perhaps you should read the last two chapters first. It may give you more enthusiasm for the task of mastering technic. And remember, results depend on technic; poor technic, poor results.

Why We Test Teeth for Pulp Vitality

It is so nearly correct that it is quibbling to dispute the statement that a tooth with a vital pulp is never abscessed—i. e., never a source of periapical infection—while the tooth without a vital pulp *may* be abscessed. Hence the necessity in the practice of dentistry and radiodontia of determining pulp vitality.

I have never encountered a case of *periapical* abscess of a tooth with a vital pulp.* Those cases which have been brought to my attention by others have all seemed to me to be mistakes in diagnosis.

For example, a man shows me a radiograph in which two approximating teeth seem to be involved in an abscess and says, "One of those teeth had a vital pulp. There's a case of abscess at the apex of a vital tooth."

*I am not considering here multirooted teeth with the pulp in one canal dead and septic and an abscess at the apex of the root while the pulp in another canal remains vital or semi-vital.

His disagreement and mine arises from the fact that he accepts what the radiograph seems to show without question, without taking into account the fact that the angle at which the radiograph was made may have been such as to cause an overlapping of a root end and an abscess cavity which have no actual connection with one another, or that the abscess cavity may lap to the lingual of the tooth with the vital pulp without involving its apex.

It is a homely comparison but it expresses my view of the matter to say that a hose or rope cannot pass through a bonfire without being burned in two. Neither can blood vessels and nerves pass through an abscess to enter a tooth without being "burned" in two.

Electric Test Compared to Other Tests

No test for pulp vitality, other than that of making a diagnostic opening into the tooth, is infallible—not even the electric test. But the electric test is so far superior to all others that it should be, and is coming to be, used by all dentists and dental radiographers. Carried to its logical conclusion—to the point of sensitivity or into the pulp cavity—the procedure of making a diagnostic opening into a tooth is absolutely reliable as a means of determining pulp vitality. But this procedure of opening the tooth is the very thing we wish to avoid if possible.

To avoid the necessity of opening teeth to determine pulp vitality, thermal tests, transillumination tests, and palpation tests are as inadequate, when compared to the electric test, as the old hand excavating instruments compared to the modern dental engine.

"Too Rosy"

While the writer fully appreciates the merits of the electric test for pulp vitality and counts the test a necessity for dentists and radiodontists, it would seem wise, however, to give a word of warning.

Enthusiasts say things like this about the test: "Absolutely painless," "Absolutely reliable," "So simple the technic of its use can be mastered in a few moments," "Enables the operator to locate devitalized teeth speedily and without fail," "If you fail to get a reaction from this test it is quite certain the pulp is devitalized."

There is good foundation for such remarks as the foregoing, and yet they are very misleading; they are too rosy. They lead men to expect too much. "Absolutely reliable" is a very dangerous thing to say about any test.

Pulp Devitalization Due to Application of the Test

Just having remarked on the care one should exercise when using that very uncompromising word "absolutely" the writer feels he is exercising necessary care and is justified in using it and saying that, so far as danger of devitalization of the pulp is concerned, the test is *absolutely safe.* As I make this statement I have in mind the use of the Faradic type of pulp testing machine. Perhaps the other types are just as safe, but I do not *know* it to be a fact from experience as I know of the safety of the Faradic machine.

Advantages of the Test

The advantages derived from using the electric test for pulp vitality, in connection with radiographic examination, are: (1) Misinterpretation of radiographs is much less likely to occur. (2) The application of the test enables the operator to select those teeth which should be radiographed with especial care. (3) Because it assists in radiographic interpretation and because it points out the particularly suspicious teeth, the test reduces the number of exposures necessary, particularly the number of make-overs necessary. (This is especially advantageous to the conscientious operator.) (4) When, in a case

of metastatic infection the patient cannot afford to have all parts of the mouth radiographed, the number of radiographs made, and so the cost, can be reduced to a minimum by eliminating those teeth from examination which respond perfectly to the electric test for pulp vitality. (5) Carelessly used, x-rays are dangerous. An x-ray tube should never be lighted unnecessarily. The use of the test lessens exposure of both patient and operator.

CHAPTER II

PULP TESTING MACHINES

The Source of the Current

To apply the electric test for pulp vitality we must have an electric current of the proper nature, i.e., a current of the correct voltage, amperage and character. The ordinary commercial current, as supplied, cannot be used. The commercial current may be passed through an electric machine and modified to meet the requisites of a current suitable for testing pulps for vitality.

Likewise the current of a dry cell may be passed through an electric machine and so modified to conform to the requisites of a current suitable for testing pulps.

Types of Pulp Testing Machines

The following are types of machines used as pulp testers, named somewhat in the order of their popularity. The first and last ones named derive their current from dry cells (batteries) while the others operate on the commercial circuit. (1) The Faradic machine. (2) The ionization machine. (3) The dental switchboard. (4) The choke coil or rheostat, or transformer. (5) The high-frequency machine. (Also known as the Tesla coil and "violet ray machine.") (6) A flashlight battery machine.

The Faradic Machine

As its place in the list of pulp testing machines indicates, the most extensively-used type of pulp tester is the Faradic machine. Everything considered, i.e., safety,

transportability, ease in handling, comparatively low cost, and high efficiency—its popularity is entirely merited.

The Parts of a Faradic Machine

The essential parts of a Faradic machine are: a dry cell, an interrupter, and a coil.

Tracing the Current Through the Machine

From the cell the current passes through a mechanical interrupter (Fig. 2) and thence to a little step-up transformer or coil, by means of which the current of comparatively high amperage (quantity) and low voltage (pressure), from the cell, is transformed into a current of comparatively low amperage (quantity) and high voltage (pressure). It is also changed from a direct current to an alternating current.

Safety

A machine which generates its own current, so to speak, like the Faradic machine, has some advantages over any switchboard attachment or any machine deriving its electricity from some powerful source of supply. In case of accident or misuse no serious results can occur, for the perfectly apparent reason that the current generated from one commercial dry cell cannot be strong enough to be dangerous. This should appeal to any one, but particularly to men whose knowledge of electricity is limited.

The manufacturer of a pulp testing machine which operates by connection to a light socket directs attention to the humming noise produced by the Faradic machine and claims the noise may frighten patients. If one would be just, it is necessary to concede the fairness of the criticism. However, which, may I ask, is more likely to

frighten the patient, the hum of the Faradic machine or the sight of an electric machine, one end of which is attached to a light socket and the other end about to be introduced into the patient's mouth?

To carry the picture still further the operator, having a machine attached to a lamp socket, now moves the pa-

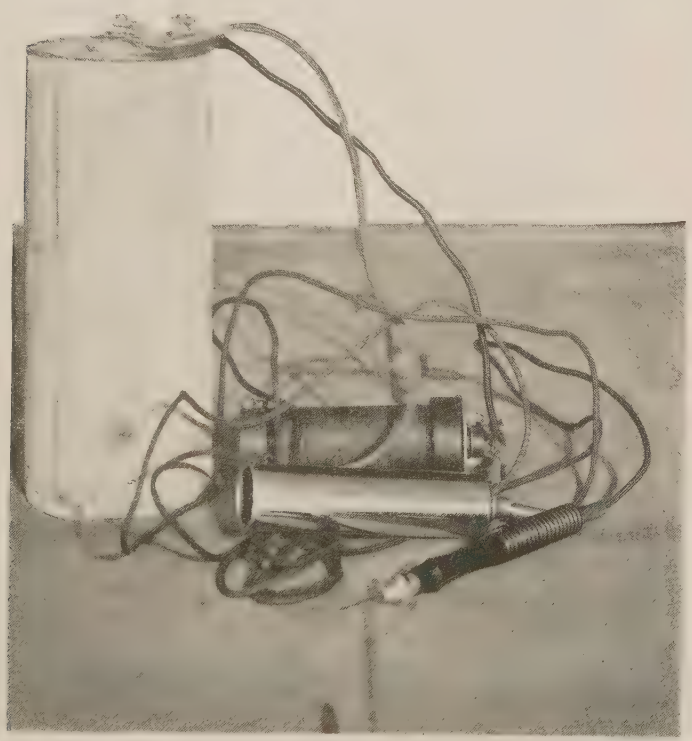

Fig. 1.—Unsightly Faradic outfit.

tient's arm from where it touches the metal trimming of the fountain cuspidor with the solemn warning, "You mustn't be in contact with any metal when I apply this test." Does the patient now feel perfectly secure?

When the Faradic machine is used, contact with metal cannot possibly result in any accident.

Transportability

The machine that generates its own current from a commercial dry cell depends only on the cell and, with the cell supplied, will operate any time, anywhere, and without variation. It can be moved from place to place in the office, or from place to place anywhere on the face of the earth for that matter. The absence of a cord, connected to a light socket, which is everlastingly upsetting something or other on one's bracket or cabinet, increases the comfort with which one moves the machine in the position for use, then out of the way again.

The ordinary dry cell can be obtained anywhere in the civilized world. A cell will give service for about one year, when it may be replaced very easily at a small cost.

The Appearance of Faradic Machines

Commercial Faradic machines, as found on the market, vary greatly in appearance. Some are unsightly and awkward to handle, especially those in which the cell and coil are not mounted together, but are separate with only wire connections. (Fig. 1.) Others are ordinary looking. Some are rather attractive. (Fig. 2.) Still others are very elaborate in appearance. (Fig. 3.) Most of them may be recognized by the patient as what is colloquially designated a "shocking machine." This is a disadvantage, for when it is recognized as a shocking machine, some patients are more reluctant to submit to its use. Perhaps they remember its sting, or perhaps it is because they do not appreciate, or may even hold in contempt, anything which is familiar to them.

An Effort and a Failure

Though the Faradic machine makes a good pulp tester, it is not without its shortcomings. Some years ago, in 1917, to be exact, I endeavored to produce a pulp testing

machine of the Faradic type which would have the following improvements over the ordinary commercial Faradic machine: (1) It was to have the right kind of a

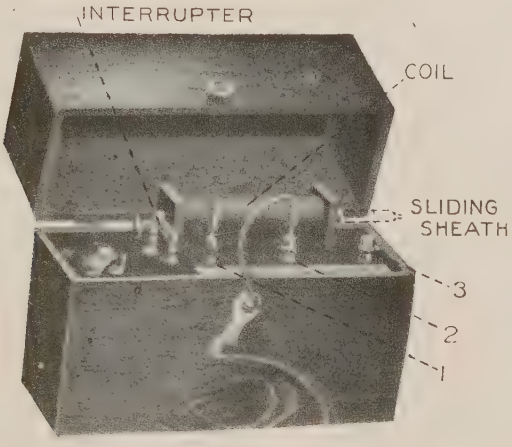

Fig 2.—Neat appearing Faradic machine.

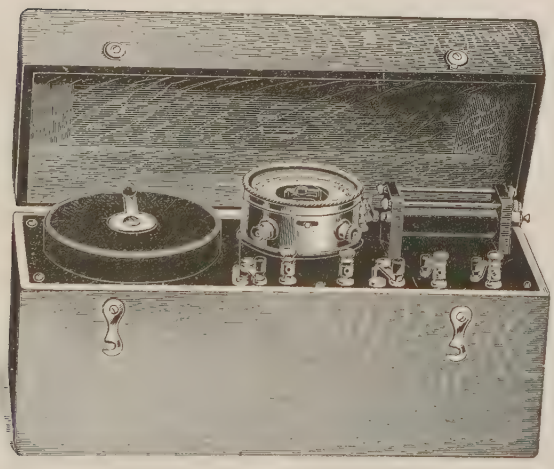

Fig. 3.—A very elaborate and expensive type of galvanic and Faradic machine.

dental electrode. (2) It was to be a neater, better looking outfit. (3) It was to have an appearance that would not remind the patient of the familiar "shocking machine."

(4) It was to have a better control of the output current. (5) It was to make less noise. (6) It was to cost only a little more than the ordinary Faradic machine.

After much trouble the machine shown in Fig. 4 was produced. Of the six objectives just given, only the first three were attained. The dental electrode was all one could desire; the outfit was really attractive; and it in no way resembled the old "shocking machine." There was no improvement whatever in the control of the output current over the controls on the ordinary Faradic ma-

Fig. 4.—A modified Faradic machine.

chine; it made more, instead of less, noise, and, owing to the increased cost of everything due to the war, its selling price was high. As though this were not enough, the machine harbored a serious, inexcusable mechanical defect. As soon as I directed attention to the serious faults of the pulp tester, it was promptly withdrawn from the market.

A Defect of Faradic Machines and How to Overcome It

Ionization machines and the expensive pulp testing machines which operate from lamp sockets, have a single

current controller which grades the output current from zero, or approximately zero, to the maximum strength needed, while the output current of the ordinary commercial Faradic machine is regulated in two ways: One, by the manner of attaching the electrodes to the machine, the other by a cylinder controller, i.e., the sliding sheath or tube, which increases the current strength as it is pulled out. (Fig. 2.) To cope with this shortcoming of having to change plugs, I have developed a stratagem or "stunt" in technic, (see Chapter V under the heading "A Valuable Point in Technic") which meets the situation and overcomes its difficulties, on most machines. It must be admitted, however, that there are some Faradic machines which are controlled so imperfectly by their sliding sheaths that they are not amenable to any stratagem and so make poor pulp testers. I should make it clear that it is not the fact that there are two modes of control which are especially objectionable, but the objection is to the nature of one of the controls; that is, the objection is to the necessity of changing uninsulated plugs from one socket into another.

However, one cannot gainsay the fact, it is easier to operate a machine which operates from a single control and grades from zero or approximate zero upward. Some of the more expensive Faradic machines are equipped with "choke coils" or rheostats instead of the sliding sheath. Such machines admit of a more perfect control of the output current.

Another Effort

Though I failed so utterly in my first effort to have an ideal pulp tester made of a Faradic machine, the failure was due entirely to preventable mistakes and such an ideal pulp tester, I am promised, is now being produced by another manufacturer.

The Ionization Machine

Equipped with the right kind of a dental electrode (Fig. 14) some ionization machines (Fig. 5) make adequate pulp testing machines. An ionization machine should not be purchased if it is to be used only as a pulp testing machine, for a good pulp testing machine of a different style, say the Faradic type, can be purchased

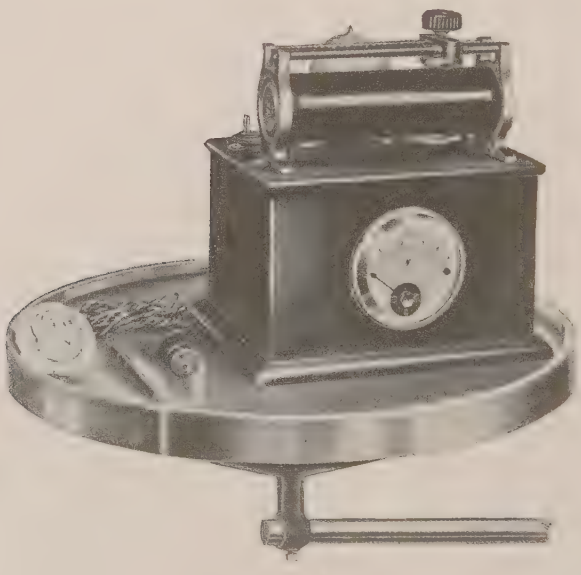

Fig. 5.—An ionization machine (on dental bracket).

at much less expense. If, however, one intends to use, or is using ionization, then the ionization machine may be used as a pulp tester if the current it generates is strong enough.

The Dental Switchboard

Some dental switchboards are, I understand, now made with sockets (places for attachment) where a suitable current for pulp testing may be obtained. If the switch-

board has been built with the idea of giving the operator a pulp testing current, doubtless such a current is available, for dentistry is fortunate in having such reliable manufacturers of electric equipment. But certainly it is "risky business" to "tap" somewhere into a switchboard, not built especially to deliver a pulp testing or ionization current in the hope that the current attained will be of the right character.

As always, when using the dental switchboard as a pulp tester, one must use the right kind of dental electrode, or failure will result no matter how perfect the current supplied may be.

The Choke Coil, Rheostat or Transformer

The machine I designate as a choke coil, rheostat, or transformer (Fig. 6) operates from a lamp socket. As the name implies, the commercial current taken from the light socket is choked back or altered by means of a transformer coil and delivered by the machine for use in the correct strength to test pulps.

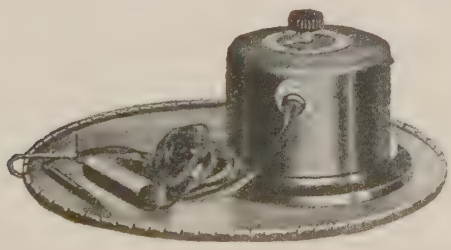

Fig. 6.—Pulp tester of the type which operates from a lamp socket.

The necessity of connecting this little machine to a light socket is disadvantageous and sometimes annoying. However, these things are not vital to the efficiency of the machine as an adequate pulp tester.

The High-Frequency Machine

(Also known as the Tesla Coil and Violet Ray Machine)

The high-frequency machine (Fig. 7) is used by some as a pulp tester. Perhaps the best way to express its status as a pulp tester is to say it has undeveloped possibilities. The fact that the high-frequency current may be applied to metal fillings and crowns without extreme pain is an advantage but the following shortcomings are serious disadvantages: (1) Ordinary insulation does not suffice; the current penetrates heavy wire insulation.

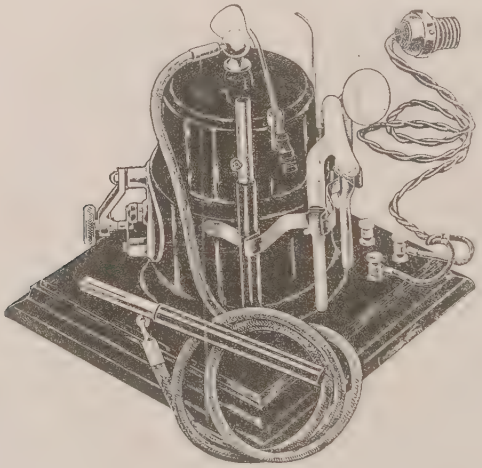

Fig. 7.—High-frequency machine. Also known as Tesla Coil and "Violet Ray Machine."

Therefore, the wire, or cord, must not be allowed to come in contact with the patient. The patient's clothing offers no protection to a current of such an extreme penetration. The current is not dangerous but it is disagreeable, and frightens patients. (2) The dental electrodes are big and awkward to handle—entirely impractical in my opinion. (3) The machine makes a distracting racket. (4) Although a small quantity of the current sparked into the metal of a filling or a crown does not cause pain, a large enough quantity will cause a pain reaction even if the

tooth is not vital. (5) The means of regulating the high-frequency current is neither very accurate nor easy.

Dr. Simpson's Opinion

I must admit that I have never used the high-frequency current except experimentally. That is I have never used it in routine practice. Dr. Clarence O. Simpson has used the high-frequency current for pulp testing for two years and so let us see what he has to say about it. I am indebted to Dr. Simpson for the statement which follows:

"Regarding the use of the high-frequency current for vitality test, let me preface the statement by admitting that it is not automatic, showing a plus or minus on an indicator when a tooth is touched, but some experience, imagination, and discrimination must be employed. There is a great difference in the response from different patients, but vitality can be determined in most cases excepting those of extreme pulp recession and crowned teeth. When a very strong current is used on a crown or pulpless tooth, it jumps to adjacent teeth with that possibility of error, but most teeth respond before the current is raised to that degree. This difficulty does not arise excepting in lower incisors or pulp recession. Insulation by rubber dam reduces the jumping, but only to a limited degree, isolation is more accurate than insulation since high-frequency current baffles all practicable insulation media. Some of the advantages of high-frequency for pulp testing are: A greater capacity than can be obtained from the usual faradic generators, the absence of shock to the tongue and on metallic restorations, and obviation of the necessity of the patient's holding an electrode."

The Flashlight Machine

Everyone has seen pocket electric flashlights of all kinds: some almost as small as a fountain pen, others much larger and giving a stronger light.

The flash light battery pulp tester is at the present time little more than an idea in the mind of one of my friends. If I am to believe what I am told (I have never seen it) an experimental machine of this type has been made and "works fairly well."

The principle of such a machine does not appeal to me. The most important single thing about a pulp testing outfit is that the dental electrode shall be right, shall be neat and easy to handle. The feature of the flash light battery pulp tester is that it shall be so small a machine that it may be handled in one hand and used as a dental electrode. Such a machine, as a machine, may be small and neat, but as a dental electrode, it is too big and awkward to handle. For this reason, if no other, I have no enthusiasm for it.

CHAPTER III

REQUISITES OF A PULP TESTING OUTFIT

A pulp testing outfit should consist of pulp testing machine, cords, dental electrode, hand electrode, cotton holder, cotton, piece of blotting paper or napkin, vessel to contain water or saline solution, mouth mirror, cotton tweezers, blanks on which to keep records.

Pulp testing machines have already been considered in Chapter II.

Cords

The cords or insulated wires which are used to connect the electrodes to the machine should be of sufficient length.

Fig. 8. Tip or plug.

Fig. 9.—Showing how some tips separate so a broken cord may be repaired.

If the tips or plugs (Fig. 8) on the ends of the cords are insulated instead of the usual metal tip, it is advantageous. When such insulated tips are used, they may be changed from one socket to another while the machine is turned on without danger of shocking the operator or patient. (The metal tip may be covered with adhesive tape to insulate if desired.)

Cords not infrequently break just where they enter the tip or plug. Some cord tips are so made that this break may be repaired easily. (Fig. 9.)

The Active or Dental Electrode

The use of inadequate dental electrodes has done more to discourage beginners and keep operators from realizing the full benefits to be gained from the test than any other thing.

Take Figs. 10, 11, and 12 as examples of the wrong kinds of dental electrodes. When using them the operator is constantly coming in contact with the uninsulated parts at the base of the electrode; and the patient's lips, cheeks and tongue are touching the uninsulated parts at the other end of the electrode. When the operator's hand touches the uninsulated parts, he receives a shock and if his other—his left—hand is in contact with the patient as it usually is, resting against the patient's face (the fingers holding a mouth mirror perhaps, and the mirror in the patient's mouth) the shock is transmitted to the patient.

Fig. 13 is a combination dental electrode and current controller. The current strength is increased by pushing in a piston very much as one pushes in the piston of a syringe. This sort of electrode is an awkward thing to handle, a fatal fault. The hand which seeks to direct a dental electrode to touch teeth at the *right spot* without touching lips, cheeks, tongue, or gum, or mouth mirror, is a busy hand; it should not be called upon to regulate the current also.

Since the application of the electric test has come to occupy such an important place in the writer's radiodontic practice, all sorts of dental electrodes have been tried. At one time a set of three different electrodes were used to reach the various surfaces of the teeth without touching the soft parts. Finally the electrode shown in Fig. 14 was designed. It is almost absurdly simple, yet it seems to be precisely the right thing for the use to which it is put. Those who have used other dental electrodes or sets of electrodes like those shown in Figs. 10, 11, and 12, for example, will share my enthusiasm for this very simple but very adequate little instrument.

The working end, i.e., the uninsulated metal part, of the electrode (Fig. 14) should be bent at an angle of about 45 degrees to the long axis of the instrument. Different

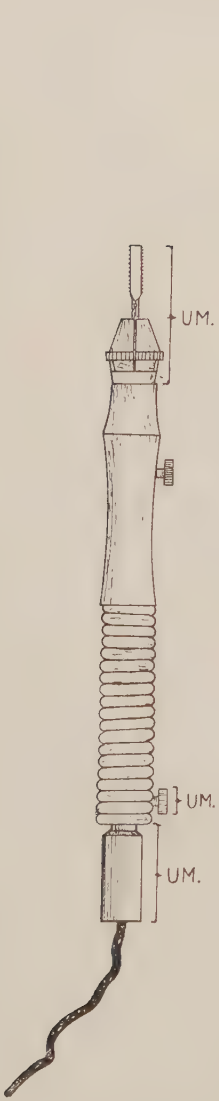

Fig. 10.

Fig. 11.

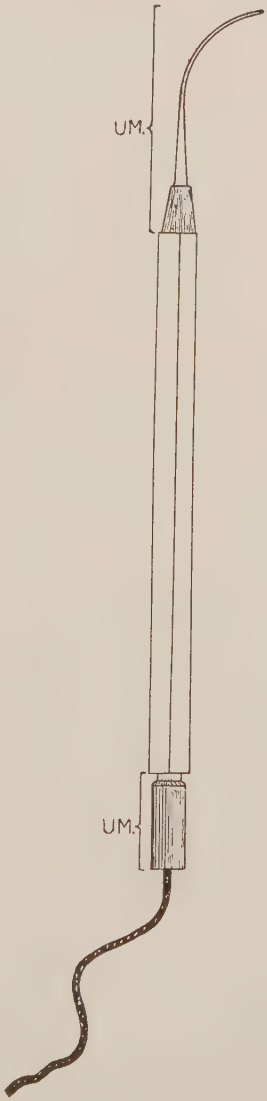

Fig. 12.

Figs. 10, 11 and 12.—Wrong types of dental electrodes. Too much exposed (i.e., uninsulated) metal, and the wrong shapes. *UM.*, Uninsulated metal.

operators may wish to vary this angle slightly. This may be done with a pair of pliers without injury to the instrument.

The Indifferent or Hand Electrode

The type of hand (also called indifferent or neutral) electrode illustrated in Fig. 15 is familiar to almost everybody.

Fig. 16 shows a camouflaged type of hand electrode. The sight of it does not remind the patient of childhood experiences with a "shocking machine," for such an electrode is not ordinarily used with a Faradic machine.

Fig. 13.—A combination current controller and dental electrode. Impractical, in the writer's opinion.

Instead of a hand electrode, there is a type of indifferent electrode which clamps on the cheek, one side inside the mouth, the other outside, which may be used, or a sponge may be strapped to the wrist, or a sponge on a wooden handle may be used, the patient having the wooden handle in one hand and pressing the sponge against the other hand, or the arm.

The cheek electrode (Fig. 17) is not a good one to use when applying the electric test for pulp vitality, especially when all or many of the teeth are to be tested; *it is in the way.*

The wrist electrode strapped to the wrist serves the purpose of an indifferent electrode nicely except that the psychic effect of strapping the electrode fast is not good with some patients. An advantage in strapping an elec-

trode in place is that it is held against the tissues at uniform pressure. Instead of strapping it to the wrist, this electrode may be held in the hand, like a hand electrode, if desired.

Fig. 14.—The right kind of dental electrode. Simple, efficient, insulated save at extreme working end. Will reach all parts of all teeth without some metal part coming in contact with the patient's cheeks, lips or tongue or operator's hands.

The sponge on a handle is an adequate electrode and serves to keep the patient somewhat occupied, a good thing from a pyschic standpoint. However, this objec-

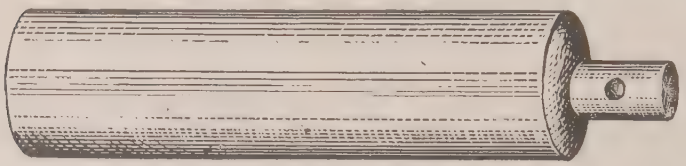

Fig. 15.—The common type of hand electrode. (This electrode is also called the "indifferent" and the "neutral" electrode.)

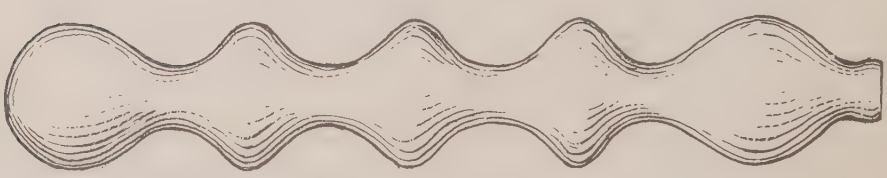

Fig. 16.—Hand electrode of special design.

Fig. 17.—A type of indifferent electrode which clamps on the cheek. Impractical for pulp testing, because in the way.

tion might be raised to the use of a sponge electrode. Care must be taken to keep the sponge moist; when dry it ceases to be a conductor of electricity.

Cotton Holder, Cotton and Blotting Paper or Napkin

Absorbent cotton is needed to wrap about the point of the dental electrode and, on occasion, to put under the tongue and in the vestibule of the mouth to keep the parts dry while the test is applied.

Dentists all have cotton holders. Physician radiographers, however, who do dental radiographic work and use the electric test to check their radiographic findings will find themselves in need of some sort of holder for cotton.

Fig. 18 shows a cotton holder designed by the writer. The feature of this holder is that a ring of blotting paper

Fig. 18. Fig. 19. Fig. 20. Fig. 21.

Fig. 18.—Cotton holder with ring of blotting paper about base.
Fig. 19.—Small medicine dish.
Fig. 20.—Dental mouth mirror.
Fig. 21.—Dental cotton tweezers.

fits over the dome of the holder and rests on the base. Those who do not wish to invest in a manufactured cotton holder may make one by cutting a hole in the tin top of a glass salve box.

When the dental electrode is dipped into water or a salt solution, to moisten it, it comes out dripping wet. To take up this excess moisture it is pressed against blotting paper or a clean napkin.

For use under the tongue and in the vestibule of the mouth, Johnson and Johnson's prepared cotton rolls will be desired by some in preference to loose cotton made into a roll by the operator.

Small Medicine Dish

Fig. 19 shows a small medicine dish, for the water or saline solution used to moisten the cotton on the dental electrode. Any sort of a container will do for the purpose, of course. The writer suggests the one illustrated only because it is neat in appearance and cheap.

Dental Mouth Mirror

A dental mouth mirror, or similar instrument, is necessary to assist the operator in keeping the tongue and cheeks out of the way while the electrode is applied to the teeth. It is also used to reflect light into dark parts and to "work to the image."

An instrument like a mouth mirror, but made of some nonconductor, would be better than a metal mouth mirror; no unpleasant shock would occur then if the end of the dental electrode happened, by accident, to touch it.

Dental Cotton Tweezers

All dentists, of course, have such tweezers. Their use in connection with pulp testing is to carry cotton rolls under the tongue and into the vestibules of the mouth, and to hold cotton to wipe off the moisture covering teeth.

Record Blanks

It does little good to test teeth with the electric test unless careful records are kept of the results. In my practice of radiodontia, as a specialty, it is my routine practice to use the test in practically all cases. With few exceptions, my procedure is as follows: First, the test is

applied and records made. Then the exposures for the radiographs are made. When the negatives are developed they are examined hastily while still wet. At this point some negatives may be made over and some teeth re-tested, depending on the particular case and the findings. The patient is now dismissed. Then, later, with the radiographs mounted and the electric test records and other records of the case before me, a "report"—i.e., a diagnosis, prognosis, etc.,—is dictated or written and

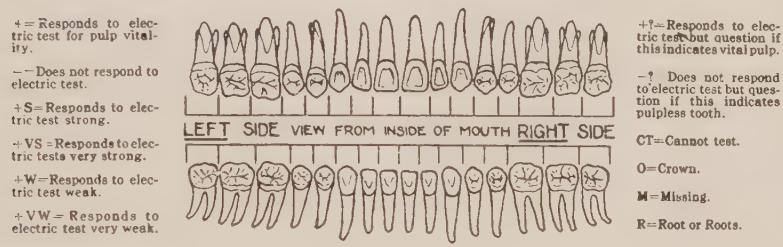
+ = Responds to electric test for pulp vitality.
− = Does not respond to electric test.
+S = Responds to electric test strong.
+VS = Responds to electric tests very strong.
+W = Responds to electric test weak.
+VW = Responds to electric test very weak.
LEFT SIDE VIEW FROM INSIDE OF MOUTH RIGHT SIDE
+? = Responds to electric test but question if this indicates vital pulp.
−? Does not respond to electric test but question if this indicates pulpless tooth.
CT = Cannot test.
O = Crown.
M = Missing.
R = Root or Roots.
Remarks:
Treatment and subsequent history: over.

Fig. 22.—Record blank used by the writer to record results of the applications of the electric test for pulp vitality.

sent, with the negatives, to the practitioner who referred the case for examination.

Fig. 22 shows the record blank used to record results of the application of the electric test for pulp vitality.

While the vast majority of teeth may be marked simply positive (+) or negative (−), it will be seen from the record sheet that, so far as this writer is concerned at least, it is not *always* a simple matter of marking each tooth plus or minus. The results of the application of the test are not always definite enough to justify this. It is fre-

quently necessary to reserve judgment until *both* the radiographic negative and the tabulated results of the application of the test can be studied.

From the record sheet it will be seen that a tooth may be marked in any one of eight ways: (1) Positive, (2) Negative, (3) Positive Strong, (4) Positive Very Strong, (5) Positive Weak, (6) Positive Very Weak, (7) Positive Questionable, (8) Negative Questionable. I use still another marking, i.e., Positive Little Weak (+L. W.).

Just how each operator will mark his chart will perhaps be a matter for personal decision, but I feel safe in saying that no operator with even a moderate degree of skill in the use of the test will find the two marks (negative and positive) sufficient.

CHAPTER IV

FUNDAMENTALS IN TECHNIC OF APPLYING ELECTRIC TEST

It will be obvious that the description, given here, of the technic of the application of the electric test is given with the Faradic type of pulp tester in mind. However, the principles of the technic set forth are similar no matter what type of machine is used.

Note the following in Fig. 23: (1) Main switch. (2) The interrupter. (3) The current controller, i.e., the sliding tube or sheath (Fig. 2), or rheostat Fig. 3. (4) The hand, or indifferent, electrode. (5) The dental, or active, electrode. (6) The little sockets where the electrode cords are connected to the machine.

There are usually three places or sockets into which the cords may be plugged. From left to right these sockets may be designated either by a letter or a number thus: L. M. R. or 1, 2, 3. Fig. 2 shows the three "sockets" or binding posts.

With the cords plugged into 1 (L) and 2 (M) the output current, is weakest. With the cords plugged into 1 (L) and 3 (R) the output current is strongest. With the cords plugged into 2 (M) and 3 (R) an intermediate current strength is attained.

It makes practically no difference about *polarity.* Either electrode may be attached to any socket.

When using a machine with the three sockets, the writer uses the connection 1 (L) to 3 (R) only for all cases to avoid the necessity of changing uninsulated plugs. (See Chapter V under the heading "A Valuable Point in Technic.")

Speaking of the control of the output current of the ordinary commercial Faradic machines with the three sockets, one may say that, like automobiles, they have three speeds or strengths:

First or low 1-2 (L-M)
Second or intermediate 2-3 (M-R)
Third or high 1-3 (L-R)

Continuing the analogy, the *current controller* is now the throttle.

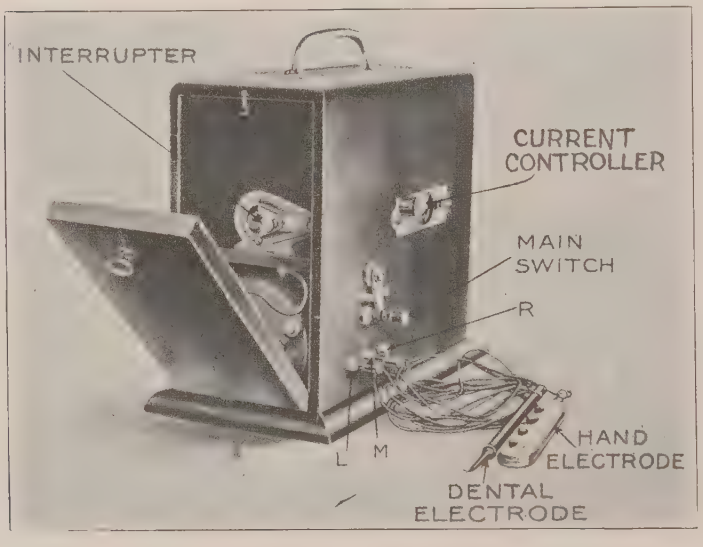

Fig. 23.

From here on the steps in technic will be numbered consecutively.

First: Plug the cords, to which the hand and dental electrodes are attached, into the machine.

Second: Wrap the metal point of the dental electrode with cotton.

Third: Moisten the cotton in water or a sodium chlorid solution.

Fourth: Expel the extreme excess moisture by touching lightly to blotting paper or napkin.

Fifth: Have patient hold the hand electrode.

Sixth: Turn on the current at the main switch. If this does not cause a humming noise, *tap the machine or the interrupter sharply.* If this does not start the humming, *adjust the interrupter screw.*

Seventh: With the current controller set to give the minimum current, *touch the tooth to be tested with the dental electrode.* (When the sliding tube is the form of current controller, start with the tube, or sheath or cylinder, all the way in, and pull it out to increase the current. When all the way out, the maximum current is delivered.)

Eighth: Advance the current controller (i.e., pull out the sliding sheath or advance rheostat) gradually, as necessary to get sensation, proceeding in this manner: Increase the strength of the current a little; touch the tooth with the dental electrode. If there is no sensation, increase the strength of the current a little more; touch the tooth with the dental electrode again and so on, until sensation is produced or the capacity of the machine has been reached.

The sensation will occur in the tooth only—not in the hand—provided the pulp is vital. If the pulp is not vital there will be no sensation with the machine operating at capacity, i.e., with the current controller at maximum.

It is not necessary to start with the current controller at minimum for all the different teeth in the same mouth. It will be found that the different teeth respond at approximately the same current strength the "irritation point"—and the current controller may be left set accordingly and advanced only when necessary to produce sensation. However, better start at minimum if the teeth give promise of being especially susceptible. The lower

teeth and teeth with the enamel worn off exposing the dentin are usually quite sensitive. (See Chapter VI for further discussion of this subject of the amount of current needed.)

Tracing the Current

The circuit, or course, or path of the current, when the Faradic or galvanic electric test is applied, is as follows: from the machine, through the dental electrode, into the patient's tooth, through the patient, out of the patient through the hand electrode back to the machine. Or the current may follow the same path but travel in the opposite direction; the test can be made with the current passing in either direction.

The circuit is entirely different when the electrode in Fig. 13 is used. The current passes from the machine through the electrode into the tooth, through the patient, out of the patient into the operator's left hand (which, of course, must be in contact with the patient) through the operator, back to the electrode held in the right hand and so to the machine, thus completing the circuit.

Perhaps I can make the foregoing clearer if I say that when an electrode like that shown in Fig. 13 is used, the operator's left hand becomes the indifferent electrode, the operator's body the conducting cord, and the right hand forms the attachment or plug into the machine.

Not having to use an indifferent electrode is, in itself, an advantage but this type of electrode has other and serious disadvantages.

When a high-frequency machine is used, no circuit is needed. The current is so high in voltage, i.e., pressure, it jumps into the tooth, as a spark, when the electrode is even brought close to the tooth before it touches. This occurs without any other electrical connection between the patient and the machine, and without the patient

touching a ground to induce the current to enter and pass through the body. A ground may be defined as any electrical path, like a gas or water pipe, for example, or a wet floor which theoretically, at least, leads eventually to the earth.

CHAPTER V

SPECIAL POINTS IN TECHNIC

A Valuable Point in Technic

As stated in Chapter IV, when the machine used has three sockets (Figs. 2 and 4), the electrode cords are plugged into "L-R," i.e., 1 and 3. It is awkward and impractical to keep changing connections (by means of uninsulated plugs especially) when a number of teeth are to be tested. However, with the cords plugged into L-R and the current controller at minimum—particularly when the cell in the tester is new—the machine may be found to deliver a current slightly stronger than desirable *for some cases.** In this event, do not actually touch the teeth with the dental electrode. Make the cotton on the dental electrode quite moist, and place it close to the tooth being tested until the water from the moist electrode is seen to touch the tooth and so establish an electric connection (Fig. 24). The amount of current passing into the tooth will vary somewhat according to the perfection of the electric connection or contact of the dental electrode with the tooth, and the water connection is obviously not as perfect as though the cotton were placed in actual contact with the enamel.

This procedure of making the "moisture contact" will also help the operator very much in cases of extremely nervous patients who always flinch in anticipation of pain whenever they feel the electrode touch the tooth, for the electrode does not touch the tooth and the patient does not know when the connection is made, *unless* he is receiving electrical sensation.

*It must be conceded here that *some* Faradic machines give such a strong current with the plugs in L-R, *and the sliding sheath clear in,* that they are not amenable to the expedient here suggested. Such machines do not make good pulp testers.

Steady the Hand

To make the imperfect, moisture contact, one must steady the hand by supporting it with the fingers against the patient's face or teeth. However, the hand manipulating the dental electrode should always be steadied in this fashion whether one is making the moisture contact or ordinary contact.

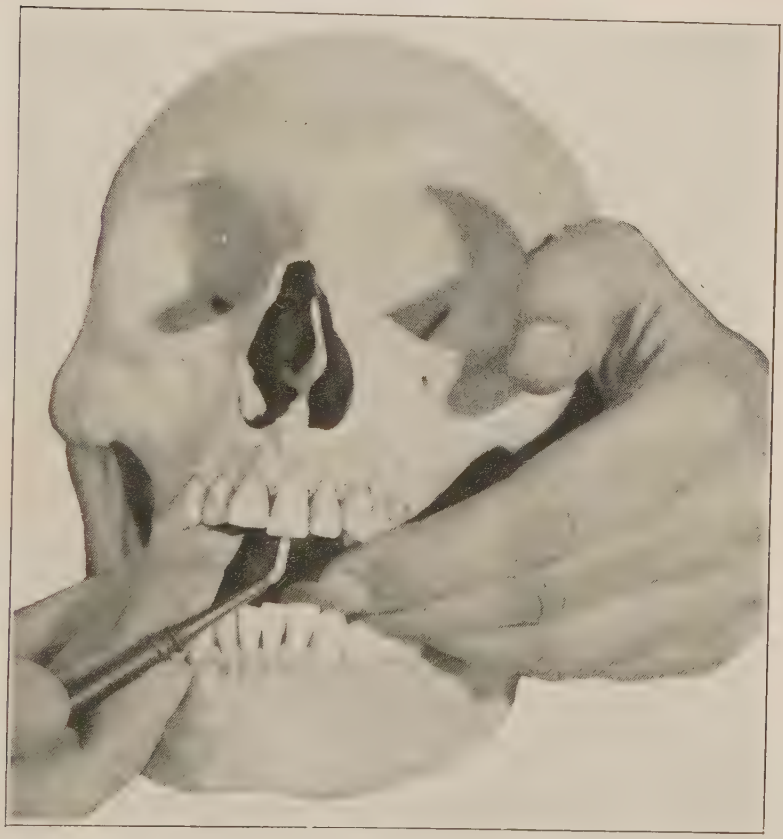

Fig. 24.—Moisture contact, not actual contact.

Keep Teeth Moderately Dry

The teeth being tested should be kept moderately dry; with cotton rolls when necessary. Otherwise the current

may pass into the gum, pericemental membrane and approximating teeth, through the saliva. The writer finds from experience it is not necessary to keep the teeth as dry as he at first supposed necessary. Cotton rolls are rarely necessary for upper teeth.

For the lower teeth, instruct the patient to "raise the tip of the tongue to the roof of the mouth," then place the cotton roll and instruct the patient to "forget about the tongue." The cotton thus applied is as useful as a means of keeping the tongue away from the teeth as to keep them dry. Use plenty of cotton, tightly rolled, under the tongue. Only about one fourth as much cotton can be placed on the buccal (facial) side of the teeth as can be placed on the lingual side.

Unruly Tongues

In cases where the tongue is very unruly, pushes the cotton out of the mouth, insists on covering the teeth when the operator wishes to apply the electrode, if the operator will allow the electrode to touch the unruly member, accidentally (?), once or twice the patient not infrequently acquires a sudden and very fortunate control over the unruly lingual member.

Wrapping the Dental Electrode

It is apparently a very simple thing to wrap the point of the dental electrode with cotton, just as the whole technic of electric pulp testing is simple, yet how easy it is to do it wrong, and therefore how often it is done wrong. A sufficient amount of cotton to cover the metal well and leave a *little* pad on the end should be wrapped *tightly* about the exposed metal. Rest the cotton between the fingers and thumb of the left hand and turn the instrument to wrap.

If the cotton does not wrap about the metal readily, flatten the sides with a stone or file. This is better than

nicking the metal with a file; the cotton goes on the flattened electrode just as readily and comes off easier. (See Figs. 25 and 26.)

Twisting the cord, and the consequent danger of breaking it may be avoided by disconnecting the electrode from the cord while the cotton is wrapped on the former.

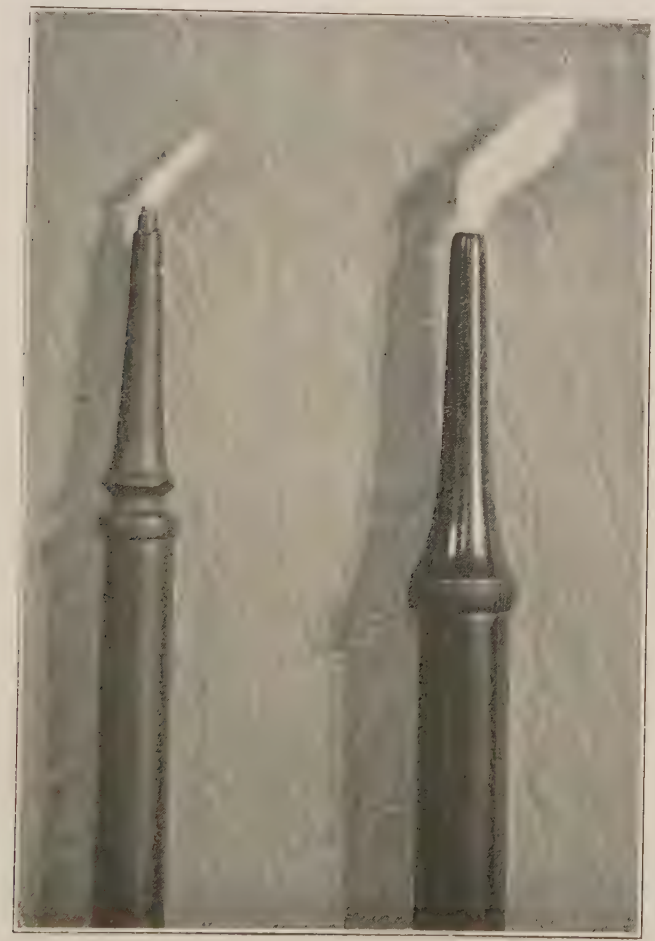

Fig. 25. Fig. 26.

Fig. 25.—Showing how the cotton should be wrapped on the dental electrode.
Fig. 26.—Wrong way to wrap the dental electrode with cotton; too much cotton too loosely wrapped.

The Application of the Dental Electrode to the Various Teeth

It does not make a *great* deal of difference which particular part of a normal tooth is selected as the spot on which to apply the dental electrode. However, the writer finds himself following the selection indicated by the table *Selection of Spot for the Application of the Dental Electrode* when fillings do not interfere with such selection.

SELECTION OF SPOT FOR THE APPLICATION OF THE DENTAL ELECTRODE

Anterior Teeth Upper and Lower	First choice: the labial surface Second choice: the incisal edge Third choice: the lingual surface
Upper Bicuspids And Molars	First choice: the lingual surface (near summit of lingual cusps, at first) Second choice: the buccal surface Third choice: the fossæ
Lower Bicuspids And Molars	First choice: Buccal or lingual surface near occlusal Second choice: the fossæ

Using Side of Dental Electrode

If touching the tooth with the end of the electrode (Fig. 27) does not produce sensation, lay the side of the electrode against the surface of the tooth (Fig. 28). By gaining a greater area of contact more electricity enters the tooth.

Keep Away from Gum Tissue

When applying the side of the electrode to facial or lingual surfaces of teeth, take care not to allow the end of the electrode to approach too near the gum line as the current may pass through moisture into the gum tissue. Take care not to mistake sensation caused in this manner for sensation due to a vital pulp; there is a difference in the character of the sensation.

When to Apply the Electrode to the Lingual Surface of Anterior Teeth

When sensation cannot be gained by applying the electrode to the facial surface or incisal edge of an anterior tooth, apply it to the lingual surface, where the covering of tooth structure over the pulp is not so thick. (Fig. 14 is of the correct shape to reach the lingual surfaces conveniently.)

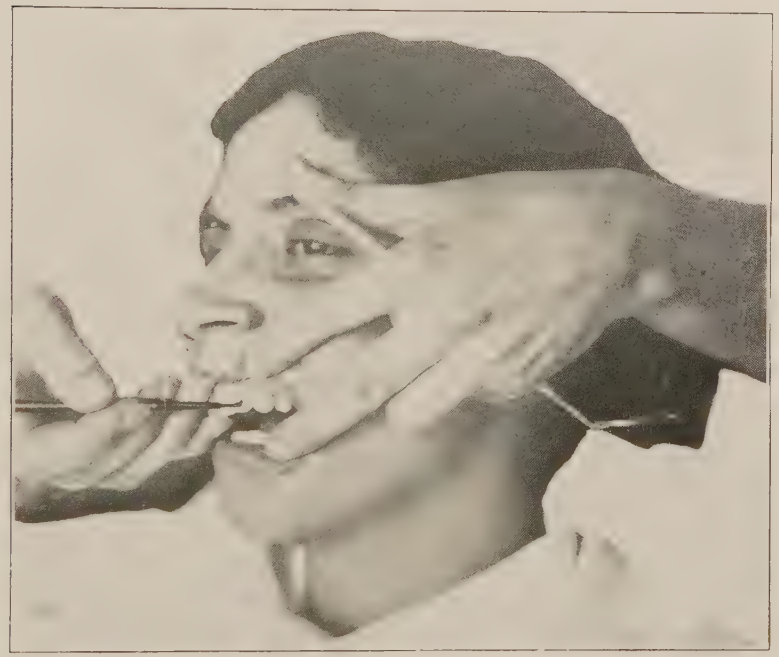

Fig. 27.

Figs. 27 and 28.—If a contact like that illustrated in Fig. 27 does not give sensation, try a contact like that shown in Fig. 28. The greater area of contact in Fig. 28 makes it possible for more current to enter the tooth. In Fig. 27 only the point of the electrode touches the tooth; in Fig. 28 the side of the electrode touches.

When and How to Apply the Electrode to Fossæ

When sensation cannot be gained by applying the electrode to the cusps or facial or lingual surfaces of the posterior teeth, apply the electrode to a cusp, then slide it down into the fossa slowly. The presence of a large filling may make this procedure impracticable.

How Much Sensation (Pain?) to Cause

It is best to use enough current to cause the patient to jump or flinch involuntarily; slightly, but definitely.

My interest was thoroughly aroused when I read the following in an advertisement for a pulp tester: "Enables you to detect devitalized teeth with certainty and

Fig. 28.

speed and *without causing pain.*" Considering my experience with other pulp testing machines this advertisement led me to believe that the manufacturers meant to say to me that they had a machine different from the pulp testing machines I had used in that it did *not cause pain* like other electric pulp testers. Investigation, however, proved that the pulp testing machine advertised was not different from others. It caused the same

sort of sensation caused by all electric pulp testers. Whether it caused only a *"distinct sensation"* as claimed, or a *slight pain* is merely a matter of diction, merely a matter of what you choose to call the sensation. Can any one tell just where "distinct sensation" leaves off and slight pain begins? The manufacturer evidently believes we should say "distinct sensation" rather than "slight pain" and I am inclined to agree with him, but patients, I fear, will continue to call it pain. Personally I should describe the sensation as a **warm, stinging sensation,** very slightly painful or very definitely painful, depending on the strength of the current.

Do not Touch Tongue, Lips, Cheeks or Gums with Dental Electrode

Take care not to touch the patient with the dental electrode anywhere but on the tooth to be tested as the sensation would be unpleasant. Hence the necessity of a dental electrode perfectly insulated except at its end. The fingers and a mouth mirror are used to hold back tongue, lips, and cheeks.

Crowned Teeth

Crowned teeth cannot be tested. Sensation is always produced whether the pulp is vital or not, if the crown is a gold shell. If the crown is one of the post-in-the-canal variety, testing is unnecessary for we know the pulp is not vital. I have attempted to test only a comparatively few teeth with porcelain jacket crowns, and have found it impossible to get a reaction: the porcelain acts as a non-conductor.

Testing Teeth with Large Metal Fillings

Teeth with large metal fillings cannot be tested at all if the filling is so large there is no spot of sound enamel to which the dental electrode may be touched. However, when there is a spot of sound enamel to which the dental

electrode may be applied teeth with large fillings can be tested much more successfully I find from experience than one would imagine.

Metal Fillings Which Should Not be Touched with Dental Electrode

When testing a tooth with an approximo-occlusal or an approximo-incisal filling, or any filling passing beneath the gum margin or touching an approximating tooth, do not touch the filling—touch the enamel only. Also avoid touching unsupported enamel with a metal filling just under it, as the effect is about the same as touching the metal, i.e., there will be a sharp positive reaction whether the pulp is vital or not.

Rubber Dam Insulation

When testing teeth with approximo-occlusal or approximo-incisal fillings in them, two or more thicknesses of rubber dam may *sometimes* be placed between the filling and the tooth approximating the filling. If kept dry, the rubber acts as an insulation, keeping the current from passing into the approximating tooth. I find, however, as I develop a better technic and judgment I am able to discontinue the use of this rubber dam insulation.

When and How to Touch a Metal Filling with the Dental Electrode

A tooth with a *small,* simple filling surrounded by sound enamel, which does not come in contact with the gum tissue or approximating tooth, may be tested by touching the dental electrode to the filling. When this is done, the *current should be weak;* also it is best to apply the electrode to the enamel and slide it cautiously toward the filling.

If the filling is large, even though it does not come in contact with the gum tissue or approximating tooth, it is not expedient to touch it with the dental electrode. If the pulp is vital, the pain produced may be very intense, if it is not vital, sensation is sometimes nevertheless caused owing to the attraction the big bulk of metal filling material has for the current, receiving it in such quantities it is transmitted to the pericemental membrane and contiguous tissues or in some cases perhaps transmitted by moisture through unfilled canals to the periapical tissues.

Unsupported Enamel

Avoid touching unsupported enamel. If it overlies a filling substantially the same effect is produced as though the electrode were applied directly to the filling, and if it covers a carious cavity the current passes through it into the cavity and so through moisture into the pulp, producing a violent reaction if the pulp is vital. Even if the pulp is not vital a reaction usually occurs from touching unsupported enamel over an approximo-occlusal carious cavity; the current passes into the moisture in the cavity and thus into gum tissue, pericemental membrane and approximating tooth.

Trouble: No Current

The first time it occurred it puzzled me: the machine (one of the Faradic type) was humming as it should, the patient held the hand electrode, the dental electrode was moist. I applied the dental electrode and advanced the current controller from the minimum to maximum; no reaction. I tried another tooth and another and another; still no reaction.

I took the hand electrode in my own hand and with the current controller at minimum applied the dental

electrode to the fleshy base of my thumb; no sensation. I advanced the current controller; no reaction.

I fingered about all the connections where the cords fasten to the machine and electrodes. Then, with the current controller again at minimum, tried the test on myself again; Ah, sensation!

"Evidently one of the connections is loose," thought I, and proceeded to test the patient's teeth. One tooth was tested, then another, then again I had no current.

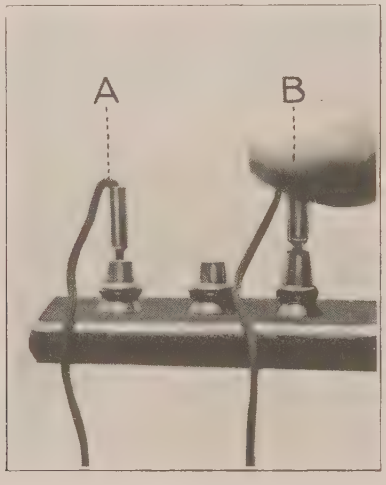

Fig. 29.– Showing where cords wear out and break *A* and one reason *B* why they break here. Some tips or plugs are made so that they may be unscrewed and the cord repaired by cutting and re-attaching at the tip. Cords break as they enter the tips at their electrode ends also.

Then it occurred to me that perhaps the wire inside of the insulation was broken at *A*, Fig. 29 as a result of plugging the cords into the machine as indicated in Fig. 29, *B*. Such proved to be the case; I could establish a connection between the broken ends of the wire inside the insulation by pushing the cords into the metal tips slightly, and break it again by pulling on the cords just a little.

Let me say emphatically that such a cord with a broken wire should not be used. Even though punching the cord

toward the metal tip may bring the broken ends of the wire in contact, a slight movement of the cord may separate them again and another slight movement bring them together again. So with this sort of thing going on obviously one can scarcely tell when a tooth fails to respond, whether it is because the pulp is not vital or because the ends of the broken wire have been separated momentarily.

Testing Out the Machine

Whenever there is any doubt at all as to whether the machine is producing current, let the operator take the hand electrode in his left hand and touch the dental electrode to the fleshy part of his thumb of the same hand as suggested above. Have the current regulator at minimum to start with at least.

Tracing the Current When Shock Occurs Changing Plugs

For a shock to occur when changing plugs the conditions must be as follows: (1) The main switch must be closed, and the interrupter vibrating. (2) The patient must be in contact with the indifferent electrode. (3) The plug, where the operator grasps it, must be an electric conductor, i.e., metal. (4) The operator must take hold of the plug which is connected (by the cord) to the dental electrode. (5) The operator must be in contact with the patient.

Shocks occurring when plugs are changed may be avoided in a number of ways, as many ways as there are requisites for the shock to occur. (1) By opening the main switch. This is rather impractical. (2) By having the patient lay down the hand electrode. This too is impractical. (3) By having insulated plugs. This is practical. (4) By changing the plug connected with the indifferent electrode. This is sometimes practical, some-

times not. (5) By the operator severing all electrical connection with patient before touching plugs. This will "work," but is a nuisance. In fact the whole procedure of changing plugs is a nuisance, as stated under the heading "A Valuable Point in Technic."

The course of the current when shock due to plug changing occurs is as follows: From the machine to the patient, through the indifferent electrode. From the patient, through the operator's hand or metal mouth mirror (in contact with the patient), through the operator's hand which grasps the plug, and thus back to the machine, or following the same path in the opposite direction.

TECHNIC ILLUSTRATED (Figs. 30 to 41)

Even my technic is not always exactly as shown in the following illustrations. The illustrations are shown not with the idea that the reader shall always do just as illustrated. However, no written description of how to do a thing can be as efficacious as to show how to do it. Therefore these illustrations, I feel certain, will be quite helpful.

There are no illustrations in this series showing the application of the dental electrode to the incisal edges and occlusal surfaces. By illustrating the application of the electrode to the facial and lingual surfaces all essential points in technic are demonstrated.

It seems obvious to the writer but it may be mentioned, however, that it is the point of the electrode usually which is used when it is applied to incisal edges and occlusal surfaces.

Read the legends under the illustrations from Fig. 30 to Fig. 41 inclusive.

Figs. 30 to 41 show the positions of the hands, mouth mirror and electrode when the latter is applied to the different teeth. It is my habit to hold the mouth mirror in the left hand even when it is not in use.

The position of the operator is to the right and just back of the patient, i.e., the usual dental operating position. Most all of the teeth can be reached from this position. It may be found advantageous to step forward from the usual position and face the patient to reach the right posterior teeth, particularly the buccal surfaces of the upper second and third molars.

Notice that the hand that holds the electrode is always supported—"guarded" to use the word usually used in this connection— against the teeth or face, so the electrode may be applied exactly to the right spot of the right tooth.

In several of the illustrations, from Fig. 30 to Fig. 41, the cotton on the electrode has been discolored with iodin to make it show plainer against the white of the teeth.

Fig. 30.—Applying the electrode to the labial surface of an upper anterior tooth. The cotton on the electrode point is stained with iodine to make it show plainer in the illustration.

Fig. 31.—Applying the electrode to the lingual surface of an upper anterior tooth. The operator "works to image," i.e., he sees the end of the electrode and the lingual surfaces of the teeth in the mouth mirror.

Fig. 32.—Applying the electrode to the buccal surface of an upper left posterior tooth. Note how the mouth mirror is used to hold away the cheek and how the hand holding the electrode is steadied by placing the fingers against the upper anterior teeth—also resting slightly against chin.

Fig. 33.—Applying the electrode to the lingual surface of an upper left posterior tooth.

Fig. 34.—Applying the electrode to the buccal surface of an upper right posterior tooth. Position of operator is farther forward than usual for other teeth. Note electrode hand is supported against lower teeth and chin.

Fig. 35.—Applying the electrode to the lingual surface of an upper right posterior tooth. Working to the image in the mirror.

Fig. 36.—Applying the electrode to the labial surface of a lower anterior tooth.

Fig. 37.—Applying the electrode to the lingual surface of a lower anterior tooth.

Fig. 38.—Applying the electrode to the buccal surface of a lower left posterior tooth. Note the cotton roll under the tongue. There is also a small roll of cotton in the vestibule of the mouth. The mouth mirror is used to retract the cheek.

Fig. 39.—Applying the electrode to the lingual surface of a lower left posterior tooth. Cotton under the tongue and in the vestibule of the mouth. Here the mouth mirror is used to reflect light onto the field of operation; the middle finger of the left hand retracts the cheek.

Fig. 40.—Applying the electrode to the buccal surface of a lower right posterior tooth. The mirror is holding the cotton and tongue down.

Fig. 41.—Applying the electrode to the lingual surface of a lower right posterior tooth. The cheek and face serve as a support for the hand holding the electrode. The mirror retracts the tongue. Cotton under tongue and in vestibule of mouth. Electrode hand retracts cheek.

CHAPTER VI

THINGS WHICH MODIFY THE STRENGTH OF CURRENT NECESSARY TO TEST TEETH

In the same mouth some teeth will require more current than others. This varies *somewhat* in proportion to the size of the tooth. However, it is quite impossible to establish the "irritation point" (the point where definite sensation is produced) of the various teeth with mathematical precision. To say, for example, that the "irritation point" for lower incisors is one (scale 1 to 10, minimum to maximum, of the current controller), of upper incisors, two, of upper cuspids, six, of upper molars five and so on. There are too many factors which modify the strength of the current needed to admit of making such a table.

A List of Factors Modifying Strength of Current Needed

Some of these factors are: (1) Age of the patient. (2) Thickness of the enamel. (3) Condition of the patient. (4) Moisture. (5) Secondary dentin. (6) Pulp stones. (7) Abrasion and erosion. (8) Carious cavity. (9) Immunity to current. (10) Fillings. (11) Size of tooth. (12) Pericementitis.

Age of Patient

The younger the patient, the larger the pulp, and so the shorter the distance to it through the tooth. Hence less current is required.

Thickness of the Enamel

The thickness of the enamel varies in different individuals, in various teeth, in different locations on the same

tooth. The thicker the enamel, the more current required. This is particularly noticeable in the upper cuspid where the enamel is quite thick. Most teeth in the mouths of adults are worn through the enamel at some place or places.

Condition of the Patient

Not infrequently the test is applied in cases where the patient has been taking some narcotic to relieve pain. More current is required in such cases and the writer recalls having a case where large doses of codein had been taken and no response at all could be obtained from the application of the electric test at the capacity of the machine. This case and one other—a case in which there was a luetic central nerve lesion—are the only cases thus far encountered where the "irritation point" could not be reached.

It is well known that alcohol has a narcotic effect and so a patient under its influence requires more current.

Neurotic patients will require less current than patients of a more phlegmatic temperament.

Moisture

Teeth which are thoroughly dry will require more current than those which are somewhat moist. Thus the lower teeth take somewhat less current than the upper. Also the amount of current necessary will vary with the moisture of the cotton on the dental electrode; the drier the cotton becomes, the more current necessary to produce a given effect.

Secondary Dentin

As a pulp recedes, throwing up secondary dentin, the current required to reach and have an effect on it naturally increases.

I have noticed repeatedly that, though the upper lateral incisors are smaller than the centrals, the laterals require more current to reach their irritation point. Perhaps the upper laterals, from some cause of which I am in ignorance, are more likely to develop secondary dentin, (this seems probable) or, it may be the enamel on them is comparatively thicker than on the centrals, or, it may be because their nerve supply is less generous and less direct than the centrals. At any rate it may be accepted as a clinical fact. and an exception to the rule that the amount

Fig. 42.—In some cases it may be expedient to make an opening through the enamel to apply the dental electrode. The advantage in this over simply drilling to the point of sensitivity is that there is less danger of accidental exposure.

of current varies directly with the size of the tooth, that upper laterals usually require a *slightly* stronger current than upper centrals.

In some cases of secondary dentin where the pulp is vital it is impossible to get any response at all from the application of the electric test. In such cases a small diagnostic opening may be made with the dental burr through the enamel, one or two millimeters into the dentin (Fig. 42) and the dental electrode applied to the dentin in this way. If the pulp is vital a response to the

electric test can be obtained in this way. In order to carry out this suggestion, the dental electrode must have a point or working end of the right size and shape (Fig. 14).

Pulp Stones

Occasionally teeth with pulp stones require more current, unless there is pulpitis, when less current is required. It is sometimes expedient to make a diagnostic opening into the dentin, then apply the test, as just suggested under the heading "Secondary Dentin."

Abrasion and Erosion

As a rule less current is required on abraded and eroded surfaces because there is less or no enamel to penetrate. If the abrasion or erosion has caused the pulp to recede and throw up secondary dentin, the presence of the secondary dentin may compensate for or, in rare instances, more than compensate for the loss of enamel.

Carious Cavity

A tooth with a carious cavity in it should be tested carefully, applying the electrode to a point on the surface of the tooth as remote as possible from the cavity. Even when this is done, taking them as a class of teeth, teeth with carious cavities in them require less current than teeth without cavities. (The current seeks the cavity through moisture.)

Immunity to Current

Practically all patients will claim to be particularly susceptible to electric shocks. While I am perfectly well aware of the fact that some patients can "stand" more electricity than others and try never to lose sight of this fact, and am now in fact directing my reader's attention

to it, I nevertheless know that each patient who claims especial susceptibility is not the exception he thinks he is. True exceptions of subnormal susceptibility are more common, I find after making allowances for fright, than cases of supernormal susceptibility. Electricians, men who work with electric currents constantly, are often subnormally susceptible, requiring excessive doses of the current to get a reaction.

It is common knowledge that application of an electric current will result in an acquired tolerance. We notice this in the application of the electric test for pulp vitality. I have had this experience repeatedly: I start to test a given tooth with the current controller at minimum to avoid undue pain. The controller is gradually advanced, touching the tooth at each advance of two or three points on the scale, until the controller stands at maximum. No definite reaction, i.e., no definite sensation, is produced. After a wait of a few minutes the test is again applied, this time starting with the current controller at maximum, and now there is a definite, unmistakable reaction. The tooth did not respond when touched with the controller at maximum the first time because of the immunity or tolerance acquired as the controller was gradually advanced.

Fillings

As stated elsewhere, unless there is a spot of sound enamel to which the dental electrode may be applied, the tooth with the large metal filling cannot be tested.

Fillings of moderate size do not interfere materially with the application or accuracy of the test. Take them as a class of teeth, however, and it will be found that teeth with moderately large fillings require slightly more current. This is due likely to the fact that the stimulus of a metal filling produces secondary dentin.

The *possibility* of the current traveling from the point of application of the dental electrode, through the tooth, into a metal filling and through it into an approximating tooth, the gum tissue or the pericemental membrane, is undeniable. But, in practice, I find I do not have this trouble. I grant that such a thing might—must—occur, but in practice it seems not to occur sufficiently to cloud diagnoses. Rubber dam may be used as an insulation as previously suggested, if desired. When I first started to use the test I used the rubber dam insulation frequently but I have not found it necessary to use it recently.

The possibility of the current traveling from the point of application of the dental electrode, through the tooth, into a metal filling, through it into a metal post in the canal and through the side of the root into the pericemental membrane, is likewise eminently possible from a theoretic standpoint. But from a practical, clinical standpoint this seems not to occur; thus far it has not occurred in my practice, except once where the post extended through a perforation in the side of the root. If one should touch *the metal* of a large filling, or unsupported enamel just over metal, sufficient current to cause pain would promptly reach gum tissue, pericemental membrane or an approximating tooth; but this would be a violation of correct technic.

Pericementitis

A tooth with a dead pulp, and *severe pericementitis* is said to respond to the electric test for pulp vitality. From a theoretic standpoint this should be true but fortunately in practice it seems not to be. In my own practice I have never been misled to believe a pulp vital by getting positive reaction from an inflamed pericemental membrane. Pressure against the tooth transmitted to an inflamed pericemental membrane will, of course, cause pain. So

the electrode should not be *pressed* against the tooth. Make a moisture contact if necessary to avoid pressure.

Differentiation Between Pulpal and Gingival Sensation

Recently I was testing an upper right second molar with a large filling. The tooth was very short occluso-gingivally. The only spot of sound enamel to which the electrode could be applied was on the mesio-lingual. I started with the current low, touching the tooth at intervals, and advanced the current controller to maximum. There was no sensation at all until the maximum current was used, and then the response was only a very weak positive (+VW). As I have said, the tooth was very short. This, coupled with the very weak response to the maximum current, made me wonder whether the response I had received was from a vital pulp or whether some of the current had leaked into the gum.

I retarded the current controller to almost zero, applied the electrode to the enamel on the mesio-lingual, then slowly pushed the point of the electrode toward the gum until it almost touched it, when the patient registered sensation.

I said to the patient: "Did that feel like it did a moment ago, when I touched the tooth before?"

The patient replied: "Oh, no. This last was different. It was—well, it was quite different."

Of course the patient did not know that the first sensation was caused with the electrode on enamel as far from the gum and metal filling as possible and with the current controller at maximum, while the second sensation was produced with the dental electrode forming a contact, by moisture, with the gum tissue. The patient knew none of the details. All she knew was that the second time she received sensation it was "Oh, quite different from the first."

Because of the difference in the essential nature of the sensation produced in the gum tissue, compared to that at first produced by touching enamel, I deduced that the first sensation came from a vital pulp. Radiographic findings bore me out in this opinion.

This is the only case in which I have tried to differentiate between pulpal sensation and gingival sensation by deliberately moving the electrode along the side of the tooth to an electric contact with the gum. The procedure gave desirable results in the one case in which it was tried and, it seems to me, it gives promise of considerable clinical value in cases where the operator is uncertain whether the sensation he produces is due to a vital pulp or leakage of the current into the gum.

I have found also that when there is a sensation produced in a pulpless tooth by a *slight* leakage of current into a large metal filling, the patient will often say, if questioned, "But that was different from the others," meaning different from the sensation produced in other teeth tested in which the pulps were vital.

I recall the old question, a fine one to argue about if you like to argue: "Are pain and touch separate and distinct senses, or is pain simply a form or manifestation, a sort of hyperesthesia, of the sense of touch?" I recall also that there are men who say that the dental pulp has no sense of touch, only the sense of pain.

I do not open these old questions to argue them. All I wish to say here is that the sensation in the dental pulp produced by the electric current is different, sharper, than that produced in the gum. Of course a considerable amount of current in the gum will produce a "sharp" sensation.

CHAPTER VII

LIMITATIONS

Every test, everything, for that matter, has its limitations. The most outstanding limitations of the electric test for vitality of the dental pulp are:

(1) Crowned teeth cannot be tested. (One must continue here to use the thermal tests which the electric test so nearly displaces altogether, or make a diagnostic opening.)

(2) *Some* teeth with very large fillings cannot be tested successfully. Fortunately there are not many such teeth.

(3) In multirooted teeth, where the pulp in one canal is vital and in another nonvital, the response to the electric test is practically the same (a little weak) as though all parts of the pulp were vital.

(4) One is doing well to determine, from the electric test, simply whether the pulp is vital or not. Even this cannot always be done. The average operator (the writer includes himself in this class) will find it impossible, except in the rarest cases, to diagnose pathologic states of the pulp with the electric test. One is treading on treacherous ground indeed when, after applying the electric test, one makes bold to say, "This pulp is vital and in a state of normality or health, and this one is also vital and much inflamed with pus infiltration." It is not practical.

A small booklet "Electro-Diagnosis of Diseases of the Pulp" has recently come to my attention. It is published by a manufacturer of electric pulp testing machines and, in the main, is quite a worthy little essay on the subject of testing pulps for vitality with electricity. However, the idea of diagnosing pulp *diseases*—not simply deter-

mining whether the pulp is vital or not, but diagnosing pulp *diseases*—seems rather "far fetched." I quote the following:

"The following scheme may serve as a guide for making a diagnosis: 1. The normal pulp responds to the current at the irritation point. 2. The irritated pulp responds to the current at the irritation point, or just slightly below it. 3. The inflamed pulp responds to the current below the normal irritation point. The more severe the inflammation, the more ready the response to the current. 4. The inflamed pulp with pus infiltration (abscess formation) responds to the current above the normal irritation point. The more severe the purulent condition, the less ready the response to the current. 5. The dead pulp does not respond at all, not even to the full strength of the current."

My advice to anyone who reads the foregoing is to disregard it. If you do not it seems to me it will confuse you hopelessly. Do not try to diagnose diseases of the pulp with the electric test; try only to learn whether or not the pulp is vital.

Do not think that one type of pulp testing machine will enable you to gain such perfect results that you can diagnose pulp *disease,* while other types of machines enable you only to ascertain whether the pulp is vital. It is the nature of the test itself, not the nature of the pulp testing machine, that makes such fineness of diagnosis as outlined above impossible.

I quote from the above: "The inflamed pulp responds to the current below the normal irritation point. The more severe the inflammation, the more ready the response to the current."

Quite true, an inflamed pulp reacts more sharply and to less current than a normal pulp. But suppose we have the combination of an inflamed pulp and secondary dentin—a not at all unusual combination? It takes less cur-

rent to reach the irritation point of an inflamed pulp, but it takes *more* current to reach the irritation point in a case of secondary dentin. So if we have both an inflamed pulp and secondary dentin, the one condition may cancel the other and the inflamed pulp react like a normal one.

I quote again: "The inflamed pulp with pus infiltration (abscess formation) responds to the current above the normal irritation point. The more severe the purulent condition, the less ready the response to the current."

A semivital pulp reacts less sharply and requires more current than a normal pulp. But suppose the dental electrode is applied to a spot on the tooth where the enamel is quite thin. Then the semivital pulp may react like a normal pulp.

One might continue citing case after case *ad infinitum* to demonstrate the futility of hoping to diagnose pulp *disease* with the electric test. Just a word further though.

Let us imagine we stand watching an operator apply the electric test. Suddenly he gets a severe reaction, the patient jumps violently, though the current used was no stronger than that used on several adjoining teeth. Ah! he has touched a tooth with an inflamed pulp! But has he? Perhaps, instead, the dental electrode has been applied to unsupported enamel, or to a metal filling, or it has come too near the gum, or it has touched a spot of thin enamel or exposed dentin, or perhaps the current has traveled through moisture into a gum-covered carious cavity or into a fault in the enamel such as a fissure or pit. But are we not agreed that the electric test is a means of determining pulp vitality, not a means of diagnosing pulp diseases?

CHAPTER VIII

APPLYING THE TEST FOR NERVOUS PATIENTS

Electrophobia (fear of electricity) is universal. As stated in Chapter VI practically all human beings are afflicted; there is difference merely in degree.

When the electric test is suggested many patients will offer strenuous objections saying "I cannot stand electricity."

The Psychology of the Situation

Before the operator proceeds with the application of the test he should take into account this mental attitude of the patient and try to overcome any undue anxiety or fear.

The test is not accompanied with sufficient pain for anyone who knows what it is like to dread it. But the operator must not lose sight of the fact that his patient may not have the slightest idea of what the test is like and imagine it very dreadful. The handling of this situation will vary with different patients, but is fundamentally the same in all cases.

The psychologic problem is a comparatively easy one and is simply that of removing or lessening excessive fear of the unknown.

Test Harmless

When the patient fears that some permanent injury may be done the teeth by the test one cannot be too emphatic in assuring such a patient that no harm will be done. The fact is that the test is absolutely harmless.

Let us imagine we are applying the test in the case of a *particularly nervous* patient.

A Sort of Written Clinic

The conversation given hereinafter is subject to great variation. It is not intended as a verbatim account of what should be said. It is a sort of written clinic.

We proffer the patient the hand electrode asking him to take it. He pushes it away or takes it testily, saying, "What's that?"

We say something like this: "Don't be afraid; you will not feel anything in your hand; you will not feel anything at all anywhere until I tell you about it. Take it." We hand the electrode to him, often closing his fingers over it as we speak.

With the patient holding the electrode we continue, "Now we want to test your teeth to see whether the pulps are vital."

"What is it? Electricity? I can't stand electricity!" This from the patient.

"It will not feel like electricity. You will not feel it in your hand at all you know, and whether you can feel it in your tooth or *not* is what we want to find out. If you feel it in your tooth at all it won't feel like electricity. There will be just a little sting (like when you are having a tooth prepared for a filling, only not nearly so severe).

"We touch the tooth only for a moment, see, like this." The operator touches his own fingernail with the dental electrode and removes it two or three times to demonstrate that the application of the electrode to the teeth is only momentary.

"You are not to even *try* to stand any pain. We want you to tell us—flinch or say 'huh'—just as soon as you feel it tingle the least bit. **This is different from any other kind of dental work; you see we can stop as soon as you feel it.** There's nothing more to do then, nothing we have to do whether it hurts or not."

"We will start with the current so weak, you will hardly feel it, *if you feel it at all.*"

As previously stated, when the machine has three sockets or binding posts, I use the tester always with the cords plugged into L and R (1-3). It is very annoying and impractical to make changes in connections to modify the current strength. So with the cords plugged into L-R, and the current regulator at minimum we are ready to demonstrate the truth of our assertion to the patient that the test can be applied with the current so weak it will scarcely be felt, if felt at all.

Since we are keeping our plugs in L-R (1-3) our current is not as weak as it could be made, not as weak as it would be in L-M (1-2) or M-R (2-3) and so we must resort to some means, other than the changing of plugs, to keep our current sufficiently weak. (In this connection it must be conceded again that there are some Faradic machines which simply give too strong a current to keep the plugs in L-R (1-3).)

This may be done as follows: Dip the cotton-wrapped end of the dental electrode in water or the sodium chlorid solution, then expel all the moisture from the cotton again by *pressing* it against a piece of white blotting paper or a napkin. Thus, if the patient is observing our actions, he sees us go through the same procedure ordinarily followed, except—and it is very unlikely that he will notice this—we *press* the moistened cotton against the blotting paper expelling practically all moisture, instead of simply *touching* the blotting paper to take up excessive moisture. With the cotton on the electrode dry, or almost dry, it is not a good conductor, so when applied to a tooth only slight sensation, if any, is produced.

If the machine can be graded to zero by the current regulator, all this is unnecessary.

Usually, as soon as the patient learns that a tooth can be touched with the dental electrode without producing extreme pain, their excessive fear is gone.

Just as soon as the patient registers having received sensation—by sound or flinching—stop and say, "Now you know what it is like—you know all about it."

The Imperfect Moisture Contact

The trick (or expedient, if you like the longer word better) of making the imperfect, moisture contact is of the utmost value. It would be impossible to test teeth, and get reliable results, for some nervous patients if it were not for this "stunt in technic." For a description of the technic of making this contact see Chapter V under the heading "A Valuable Point in Technic."

Only a Few Patients Difficult to Handle

I regret having failed to make my consideration of the handling of patients shorter. I fear I may lead my readers to believe the application of the electric test is always attended with considerable difficulty and the necessity for much explanation, which is not the case.

Offer No Explanations or Comments Unless Necessary

The foregoing is calculated to teach the beginner to meet any emergency which may arise. Let it be clearly understood that it is not advisable to give any sort of explanation to a patient unless the patient's state of mind is such as to make it necessary. When the patient is not afraid it is obviously unnecessary to take steps to relieve fear. Indeed such a course would create fear where it had not existed. Talk to the patient about the test as little as possible, but as much as necessary. As the operator becomes more skillful in the use of the test he will find less need for conversation with his patient regarding it.

Children

As far as possible I treat children as though they were grown-ups. The most notable exception is to say to a good natured, unafraid child something like this: "Now this thing will tickle a little bit. I want you to tell me when you feel it start to tickle and I'll stop. I just want to see if your teeth are alive by finding out if they are ticklish." The use of the word "tickle" has a splendid psychologic effect, and if the operator is careful he need cause no more sensation than the child will accept as "ticklish." If the child is too ill-natured or too afraid, this effort at suggestion will fail, but it usually "works" beautifully.

CHAPTER IX

ANSWERING ADVERSE CRITICISM

Comparatively little has been written on the subject of the electric test for pulp vitality. What has been written has been by men who use the test and believe in its efficiency. Scarcely anything at all has been written in the way of constructive criticism, indeed hardly anything at all has been written in the way of any sort of criticism.

Verbal criticism, however, is not at all uncommon.

The only thing I am able to locate just now in the way of adverse criticism appeared in *Dental Cosmos,* October, 1918. I quote from this article: "At a clinic all hands agreed that a certain tooth appeared to be devitalized. The pulp tester was applied, and it gave positive and unmistakable signs that the pulp was vital. A skiagraph was then taken, which showed that the roots were filled!"

Such reports as these fail utterly to convince or even to approach convincing the writer of the inadequacy of the electric test, for I ask myself such questions as these: Did the operator touch a metal filling? Did the operator touch the gum tissue? Did the operator touch unsupported enamel? Did the operator use the wrong kind of a dental electrode and touch the patient's lip or cheek? Was the patient so nervous that he jumped without receiving sensation? Was the tooth sore and was the electrode pressed against the sore tooth thus causing pain? Was the tooth covered with moisture and did the current travel through the moisture to an adjoining tooth? In short, did the operator know how to apply the test, for certainly the inefficiency of a test is not proved when it is applied by an inefficient operator?

I quote again from the article referred to above. It being the only written thing I have to attack, let me attack it in several places. I quote the following as an example of bad logic: "He was asked, 'Is the electrical test always positive?' He answered, 'No.' To the query, 'Is the thermal test always positive?' he replied 'No.' To the question, 'Then in a final analysis the *only real way,* in this the year 1918, to tell whether or not a pulp is dead or alive is to drill into it'? the answer was 'Yes.'

"And there you are!"

Following this sort of reasoning one might claim that "the only real way" to prevent insanity is to cut off the head. An autopsy is a "real way" of making a diagnosis but it is destined to remain a sort of a last resort.

There are some teeth, the vitality of the pulps of which cannot be determined except by making a diagnostic opening, but there are millions, millions upon millions, the vitality of the pulps of which can be determined by the electric test, or by the electric test and the making of a radiograph.

While written criticisms of the test are scarce, verbal ones, as I have said, are far from scarce. Here is a typical verbal one, addressed to me recently by one of my friends: "I applied the electrode to a simple occlusal filling and the reaction was positive and definite. I opened the tooth and found the pulp putrescent."

I have no reason whatever to doubt the truth of such statements, but let us take a case such as the one just mentioned and apply our electric test before making a radiograph, making records of the application of the electric test. We will suppose it is a lower first molar. It is my custom to test at least the two teeth approximating the tooth under examination. So, then, we test the second bicuspid and the second molar and find that both of them respond. We test the first molar, applying the electrode to the enamel and find that it does not re-

spond. Accordingly, we make the current weaker and slide the electrode on to the metal of the occlusal filling; and let us imagine that still the tooth does not respond. We increase the current and now we get a response.

Under such circumstances shall we simply mark our chart positive for the first molar? By no means. I would mark such a tooth "positive questionable" (+?) or perhaps make a special note under "remarks" saying "Positive on amalgam filling, negative on enamel."

Such records then would cast suspicion upon this tooth.

Suppose now we go ahead and make a radiograph and we find the metal filling running to, or perhaps slightly into, the pulp chamber. We also find a very slight bone change, a slight osteoclasia, and a suggestion of osteosclerosis, at the apex of one of the roots. This bone change is not sufficient in itself to be taken as an indication of periapical infection but coupled with the other evidence we have gathered—manner of response to the electric test and the metal filling penetrating deeply toward the pulp—this bone change may be taken as further evidence that the pulp is probably not vital. (The course of the current to produce sensation could be through the amalgam filling, through the moisture in the septic canals, out the apical foramina to vital tissue.)

With such an array of evidence indicating a nonvital pulp certainly any diagnostician, worthy of the name, would suspect a dead pulp, even if there was response upon the application of the dental electrode to the metal filling.

It just occurs to me: I did not ask my friend why he opened the tooth. Perhaps he took into account some of the things I have mentioned, or perhaps subjective symptoms were such as to cause him to open the tooth. And this reminds me to give warning that the electric test is not intended to take the place of all other diagnostic measures. Symptoms should be considered, of course.

Everything considered: The inadequate dental electrodes which have been used. The inadequate machines also. The erroneous idea that the technic for electric pulp testing requires almost no knowledge or skill, that the entire subject is covered in the eight fundamental steps in technic set forth in Chapter IV, in less than five hundred words. The unwillingness to accord the test and its technic sufficient respect. I say, everything considered, the wonder is not that some men attack the test but that it is as popular as it is.

CHAPTER X

CLINICAL VALUE OF THE TEST

There are many sorts of cases in which the electric test for pulp vitality may be applied to great advantage by the diagnostician. It is not possible to mention all the circumstances under which its application will prove helpful, and, if it were, the mere mention of such circumstances and cases would fail to impress the reader or teach him so effectively as the illustrated description of cases.

Nevertheless, some written effort to indicate the extent of the value of the test seems necessary and is set forth in this chapter. To get a fuller realization of the clinical status of the test, see the illustrations in the next chapter.

The following is a list of cases and circumstances in which and under which the test may be used to advantage:

(1) In cases of systemic disease to determine which teeth are most suspicious. (2) Where no x-ray machine is available. (3) To check all x-ray findings. (4) To find teeth with dead pulps which could not be found by any other means. (5) To find abscesses which might otherwise be overlooked because they fail to show in radiographs made at certain angles. (6) To assist in recognizing very slight osteoclasia. (7) To avoid mistakes when the end of a root and an abscess cavity (with no connection between the two) overlap in the radiograph due to the angle at which the exposure is made. (8) To avoid misinterpretation when the abscess cavity laps to the lingual or facial of the adjacent teeth. (9) To differentiate between the mental foramen and an abscess cavity. (10) To differentiate between the anterior palatine,

or incisive, foramen and an abscess cavity. (11) To differentiate between the antrum of Highmore and an abscess cavity. (12) To differentiate between the somewhat radiolucent area which sometimes appears in the apical region of upper lateral incisors, due to the canine, or incisal, fossæ, and radiolucence caused by infection and pathologic bone change. (13) To differentiate between nostril spots and abscesses. (14) To aid in the recognition of nasal fossæ spots as such. (15) To aid in the recognition of the inferior dental canal as such. (16) To differentiate between a very small abscess cavity and an unusually large periapical space. (17) To differentiate between a cancellous spot of unusual appearance and an abscess cavity. (18) To assist in differentiation between pathologic and physiologic conditions about the buccal roots of the upper molars. (19) To assist in differentiation between an absorbed, roughened root and a radiograph made with the rays directed through the tooth diagonally from facial to lingual. (20) To differentiate between partially formed root and an abscess. (21) To determine how many teeth are involved in an abscess. (22) To assist in differentiation between dentoalveolar abscess and periodontoclasia (pyorrhea).

1. In Cases of Systemic Disease to Determine Which Teeth Are Most Suspicious

The determination of which teeth are most suspicious aids in many ways. If the cost of examination is to be cut to the minimum those teeth which respond perfectly to the test need not be radiographed. And even if all of the teeth are to be radiographed, those which respond to the electric test need not be radiographed or studied with such care as those which cannot be tested or test negatively. Thus the number of negatives it is necessary to make is reduced and at the same time the operator's at-

tention is directed to those parts where make-overs are most likely to be indicated.

It is always the part of wisdom to avoid unnecessary x-ray exposure, and in some emergency cases where the operator happens to be operating with inadequate protection this is especially true.

Much has been said of x-ray pictures relieving the dental operator of the necessity of working in the dark. The electric test relieves the x-ray operator himself from the handicap of working in the dark and so enables him to make a better examination.

In cases of systemic disease examination of the mouth for infection is made in one of three ways: (1) All teeth and all parts of the mouth are radiographed. (2) All teeth which do not react positively to the electric test, or cannot be tested, all regions from which teeth are missing, and all teeth affected, or thought to be affected, with pyorrhea and all regions of unusual appearance are radiographed. (3) The teeth which react negatively and those which cannot be tested are radiographed.

For the reasons already given, the writer applies the electric test even if all the teeth are to be radiographed and whether it is permissible to eliminate parts of the mouth from the necessity of examination at all or not depends on two things: The operator's judgment and the electric test.

When the examination is for pulpless and abscessed teeth only, those regions in which the teeth respond perfectly and positively to the test need not be radiographed. When the examination is more inclusive, such regions may be radiographed and may reveal such lesions as carious cavities, overhanging fillings, incipient pyorrhea, odontomata, and supernumerary teeth.

Where we speak of the application of the test we assume that its application is made in a competent, intelli-

gent manner, for unless this is the case, the electric test, like all tests under similar circumstances, is useless.

2. Where No X-Ray Machine Is Available

Where no x-ray machine is available the only way to determine which teeth are pulpless with any degree of accuracy is to use the electric test. This will, in most cases, enable the operator to locate the pulpless teeth quite successfully. A friend who "believes in the extraction of all pulpless teeth" maintains that the determination of which teeth are pulpless is all that is necessary and that if this can be done with the electric test then radiographs are unnecessary. He fails to consider the value of the radiograph to verify his electric test findings and, further, the radiograph, by showing the amount of bone destruction, assists in curettement, so it helps even the extreme extractionist. It is necessary to remove shell crowns before the teeth carrying them can be tested.

Where we have the combination of a seriously sick patient and no x-ray machine available, the test may be used to locate the pulpless teeth. Thus extraction of teeth with vital pulps may be avoided and at the same time all periapical infection is eliminated.

3. To Check All X-Ray Findings

Both the electric test and the radiograph are quite susceptible to error—to misinterpretation let us say—but taken together, letting the one check the other, chance for error, if not entirely eliminated, is reduced to an agreeable minimum.

The writer started to use the electric test in his practice of radiodontia in selected cases and came gradually to use it in all cases. It is my practice now to apply the test first, in all cases where radiographs are to be made, *and to make records of the results of the application of the*

test on the chart illustrated in Fig. 22. From the records on the electric test chart, the recorded history of the case, and the finished, mounted radiographic negatives, a diagnosis and prognosis are given.

In cases where a tooth is suspected of being pulpless or abscessed and an x-ray examination is to be made of such a tooth I make it an invariable rule to test at least the two teeth approximating the one under examination.

4. To Find Teeth with Dead Pulps Which Could Not be Found by Any Other Means

A tooth with (as yet) no periapical bone change, or filling material in the pulp chamber or canals that has a dead pulp cannot be located by means of radiographs. Such teeth may be found by the use of the electric test. When the symptoms (there may or may not be symptoms) are such as to place a certain tooth under suspicion the electric test *will assist* in diagnosis.

5. To Find Abcesses Which Might Otherwise be Overlooked Because They Fail to Show in Radiographs Made at Certain Angles

Let us consider a hypothetic case, the like of which is frequently met. A radiograph is made of a certain tooth. It shows no abscess and no canal filling, but the electric test for this tooth is negative. Also perhaps there are abscess symptoms, a fistula in the vicinity. Another radiograph is made at a different angle and shows osteoclasia. Thus an abscess cavity is found which, had it not been known that the tooth did not have a vital pulp, would have been overlooked.

Foreshortening of the upper teeth may result in the failure of an existing abscess cavity to show. Slight elongation is sometimes advantageous; it enables the operator to see abscess cavities which might otherwise be overlooked.

6. To Assist in Recognizing Slight Osteoclasia

An area of osteoclasia may be so small that one is unable to say definitely whether it is really osteoclasia or not. In such cases, whether the pulp is vital or not may be the deciding factor. If the pulp is vital, of course the suspicious area is not a bone change due to infection, but if the pulp is not vital, a suspicious area can be classed as osteoclasia due to infection, especially if there is some osteosclerosis also.

7. To Avoid Mistakes When the End of a Root and An Abscess Cavity (With No Connection Between the Two) Overlap in the Radiograph Due to the Angle at Which the Exposure Is Made

When a tooth seems to be involved in an abscess, but responds to the electric test, it is sometimes possible to make radiographs at different angles which will show that, after all, the suspected tooth is not involved in the abscess cavity. If a root end is more or less surrounded by an abscess cavity it will register in radiographs, if at all, at the end of the affected tooth. But if the abscess cavity is at the side of the root, and the root end only appears to be involved in the abscess due to the angle of the x-rays, a shadow of the abscess cavity can usually be cast on the film away from the root end.

The electric test thus indicates the expediency of making more radiographs at different angles in such cases and keeps the operator from accepting false radiographic evidence. See Figs. 69 and 70.

Abscesses arising from the lingual roots of upper bicuspids not infrequently have the radiographic appearance of involving the cuspid and lateral incisor. This appearance of involvement in the radiograph may be due to actual lapping of the abscess cavity to the lingual of the cuspid or lateral or may be due to the angle at which the exposure is made.

8. To Avoid Misinterpretation When the Abscess Cavity Laps to the Lingual or Facial of the Adjacent Teeth

It is possible for an abscess cavity to lap to the lingual or facial of the roots of the adjacent teeth in such manner that healthy teeth have the appearance of being involved in the abscess. In such cases the electric test is often the deciding factor and so of the utmost importance.

This lapping of an abscess cavity is most likely to occur to the lingual in the upper teeth. Cysts, as well as abscesses, may lap to the lingual or facial of healthy, uninvolved teeth.

9. To Differentiate Between the Mental Foramen and an Abscess Cavity

The fact that the mental foramen may have the appearance of being an abscess of the first or second (usually second) lower bicuspid has become common knowledge. Such common knowledge in fact that the writer has seen an abscess cavity mistaken for the mental foramen!

Where the electric test can be applied and is positive, the operator may know that a radiolucent area at the apex of a lower bicuspid is the mental foramen. Where the response to the test is negative, the operator should look elsewhere in his radiograph to locate the mental foramen. It is sometimes best to make an extraoral radiograph for this purpose. Where the result of the electric test is definitely positive all doubt is immediately and completely removed.

10. To Differentiate Between the Anterior Palatine, or Incisive, Foramen and an Abscess Cavity

As with the mental foramen, the fact that the palatine foramen may be mistaken for an abscess is becoming so well known that there is danger of abscesses being mis-

taken for the anterior palatine foramen. And, as in the case of the mental foramen the electric test, when positive, enables the operator to make a prompt and accurate diagnosis.

When the test is negative an intraoral radiograph may be made in such manner as to cast the shadow of the palatine foramen between the roots of the central incisors, instead of the apex of the root of one of them.

I have mentioned it before but it is of sufficient importance to justify repetition: *When a radiolucent area can be cast away from the end of the root, it is not an abscess involving the end of the root.*

11. To Differentiate between the Antrum of Highmore and an Abscess Cavity

One familiar with the appearance of intraoral dental radiographs does not often have a great deal of difficulty in distinguishing the difference between the antrum of Highmore and an abscess cavity, but one less skilled in interpretation often has a great deal of difficulty in this respect. And even one skilled in interpretation will feel much more secure in the accuracy of his opinion if he verifies it by applying the electric test and finds that the pulps of the bicuspids and molars are vital.

Some points of difference between the radiographic appearance of the antrum of Highmore and an abscess cavity are: Of course abscess cavities are usually not nearly so big as the antrum, but a small antrum may be much smaller than a very large abscess. The outline of the antrum is more symmetrical, less jagged, than the outline of an abscess cavity, as a rule. Also the outline of the antrum is rimmed with a thin radiopaque line, representing the walls of the antrum.

12. To Differentiate between the Somewhat Radiolucent Area Which Sometimes Appears in the Apical Region of Upper Lateral Incisors, Due to the Canine, or Incisal Fossæ, and Radiolucence Caused by Infection and Pathologic Bone Change

This seems to the writer to require no special explanation. As always the value of the electric test hinges on the fact that a tooth with a vital pulp cannot be abscessed.

13. To Differentiate Between Nostril Spots and Abscesses

Like other things which cause radiolucent areas at the apices of the roots of teeth without actual involvement of the ends of the roots of the teeth, a nostril spot may be cast away from the end of the root by changing the angle of the x-rays.

14. To Aid in the Recognition of Nasal Fossæ Spots as Such

Nasal fossæ spots are so characteristic in appearance that it is only occasionally that one is found which really resembles an abscess cavity. Dr. Noboru Teruuchi points out the fact that bilateral abscesses of similar size and shape, arising from the apices of the roots of the laterals, or centrals, might be mistaken for nasal fossæ spots.

15. To Aid in the Recognition of the Inferior Dental Canal as Such

The inferior dental canal is characteristic in appearance to the operator familiar with radiographs, but may be mistaken for a pathologic lesion by one less familiar with the appearance of dental radiographs. A positive reaction from the application of the electric test would relieve uncertainty in some cases.

16. To Differentiate Between a Very Small Abscess Cavity and an Unusually Large Periapical Space

By periapical space the writer does not mean either an air space or a vacuum, but a space between the root end and the bone; a space doubtless filled with vascular tissue.

In the past there has been some discussion as to whether such spaces exist. I have seen them, and they resemble a small abscess cavity. One cannot confuse a large periapical space with a small abscess if the electric test is applied and the pulp found vital.

As further aids in differential diagnosis I may say that osteosclerosis is likely to occur in case of the abscess and that the lamina dura can probably be seen unbroken in the case of the large periapical space.

17. To Differentiate Between a Cancellous Spot of Unusual Appearance and an Abscess Cavity

In some cases the cancellous openings in the bone are abnormally large and I have seen them mistaken for abscesses. Such a mistake could not occur if the electric test were applied and the pulps of the suspected teeth found vital.

18. To Assist in Differentiation Between Pathologic Conditions and Physiologic Conditions about the Buccal Roots of Upper Molars

When the parts are in a state of perfect health there are nevertheless sometimes radiolucent areas at the apices of the buccal roots of the upper molars. Also the distobuccal root of the upper molar is so small that it sometimes fails to show clearly in radiographs and leads the uninitiated to believe that there is root absorption. When the fact that the pulp in the tooth is vital can be established by the application of the electric test uncertainty in x-ray interpretation can be eliminated.

19. To Assist in Differentiation between Absorbed, Roughened Root and a Radiograph Made with the Rays Directed through the Tooth Diagonally from Facial to Lingual

When a radiograph of the upper bicuspids is made with the rays passing diagonally through the teeth, the roots of the teeth in the radiograph not infrequently have a fuzzy, indistinct appearance. I have seen this appearance of the root mistaken for absorption of the root. Since the roots of vital teeth do not absorb, except in the most extraordinary cases, or in cases of pressure from unerupted tooth bodies, the establishment of the fact that the pulps are vital by means of the electric test eliminates all except the remotest possibility of root absorption.

In the case of the upper bicuspids the small roots sometimes fail to show distinctly and so may seem to be absorbed, like the distobuccal roots of upper molars.

20. To Differentiate between Partially Formed Root and an Abscess

If the fact that the pulp is vital can be established by means of the electric test, this mistake cannot occur. It is less likely to occur with the dentist who will take into account the age of the patient.

21. To Determine How Many Teeth Are Involved in an Abscess

The writer recalls the first very large abscess he encountered in which five teeth were involved. By checking up the x-ray findings with the electric test and finding that those teeth which seemed to be abscessed did not respond to the electric test I felt much more certain of my diagnosis than I could have otherwise.

22. To Assist in Differentiation between Dentoalveolar Abscess and Peridontoclasia (Pyorrhea)

When serumal calculus on the roots of a tooth causes irritation, which in turn produces inflammation, and which in its turn results in suppuration, and the pus happens to penetrate the external alveolar plate, instead of following along the side of the root and discharging at the neck of the tooth, the clinical picture is almost identical with that of an abscess. But if the electric test shows that the tooth under suspicion of being abscessed has a vital pulp then the seat of the suppurative process may be looked for along the side of the root instead of at the apex.

THE TEST AS AN AID IN THE INTERPRETATION OF RADIOGRAPHS

CHAPTER XI

THE TEST AS AN AID IN THE INTERPRETATION OF RADIOGRAPHS

The style of presenting the evidence set forth in this chapter is not formal, but, I hope, it is convenient and practical. The cases illustrated are arranged somewhat in the order of the classes of cases enumerated in Chapter X.

Due allowances must be made for the loss of detail in halftones as compared to original negatives.

Where definite statements are made regarding findings it is to be understood that subsequent treatment and history verified the diagnoses.

I shall, throughout this chapter, occasionally use an illustration which I cannot interpret. The reason I cannot make an interpretation is that I do not have electric tests to guide me and the reason for using the illustration without giving a diagnosis of the case is to show the reader how heavily I lean on electric pulp test findings.

Fig. 43. Failure of the lower first bicuspid to respond normally to the electric test directed attention to the tooth. The radiograph shows evidence of a large abscess cavity. There were no local symptoms or signs at all. Had the electric test not been used a radiograph would not have been made of this tooth and the area of infection would not have been found. On the enamel of the lower first bicuspid the electric test was definitely negative. On the metal of the occlusal filling it was very faintly positive. Normally it should have been positive (+) on enamel and positive very strong (+VS) on the metal filling. Hence I have said that the tooth did not respond *normally* to the test, even though a faint positive was obtained on the simple occlusal filling.

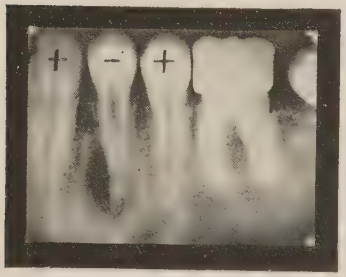

Fig. 43.

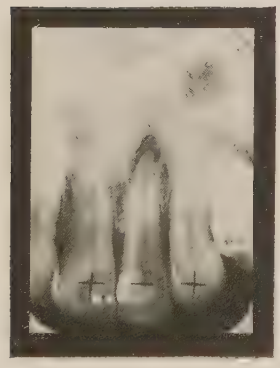

Fig. 44.

Fig. 44. If one were making a casual examination of the mouth to determine which teeth were "suspicious" and should therefore be radiographed, it is unlikely that the little filling in the upper lateral incisor would arouse suspicion of a dead pulp. But when the electric test is used and the lateral fails to respond, suspicion is aroused. The radiograph shows the lateral incisor abscessed.

Fig. 45. The abcessed lower lateral was located by means of the electric test. The symptoms were such—there was a fistula—that it was known that one or more of the six anterior teeth were abscessed. Just which one was determined by the use of the electric test. The test finding was verified by the radiograph. Also the radiograph shows the extent of the loss of osseous tissue. In the absence of an x-ray machine the offending tooth would have been located by the test unaided by radiographs. No cavity in the abscessed tooth.

Fig. 46. History of this case when it presented was that "an abscessed lower lateral incisor has been extracted a month previously. Pus still discharging from the socket of the extracted tooth." The electric test was applied to the central incisor and cuspid approximating the socket of the extracted tooth. The central incisor responded positive (+) the cuspid negative (−). Thus a diagnosis was made readily enough before the radiograph was made. The radiograph verifies the diagnosis, showing the fistulous tract of the abscess arising at the apex of the cuspid and passing over into the socket of the extracted lateral incisor.

Fig. 45.

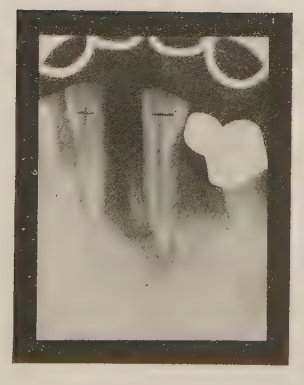

Fig. 46.

Fig. 47. Three blind abscesses at the apices of the upper incisors. The fact that the pulps were dead in these teeth could have been established by the use of the electric test. The radiograph was necessary to show the amount of bone destruction. The teeth have artificial enamel fillings in them. I am told that the *first* silicious cements placed on the market contained some ingredient which devitalized pulps. I cannot vouch for the truth of this. Absolutely all I know about the matter is this: I have found a sufficient number of dead pulps in teeth, with artificial enamel in them, so that I am particularly careful to test such teeth for pulp vitality. More of this material is being used all the time but I do not notice any increase in pulp death in teeth filled with it which would seem to indicate that the silicious cements now in use do not contain a pulp devitalizing ingredient. (Radiograph by Alger of Los Angeles.)

Figs. 48 and 49. These two radiographs illustrate the necessity of checking up x-ray findings. In Fig. 48 the abscess arising from the lower cuspid seems to involve the adjoining lateral incisor and perhaps the central incisor also. But the electric test for pulp vitality indicates that the pulps in the incisors are vital and therefore not involved in the abscess.

In Fig. 49 the central incisor looks as though it *might* be involved in the abscess of the lateral incisor though its appearance is no more suspicious than the lower incisors, particularly the lateral, in Fig. 48. The fact that the upper central is negative to the electric test while the lower incisors are positive, is what tells us that the upper incisor is abscessed and that the lower incisors are not.

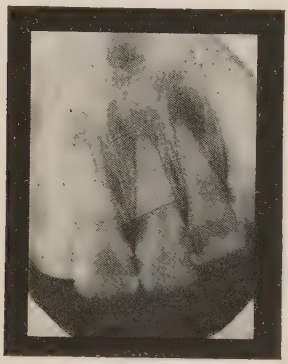

Fig. 47.

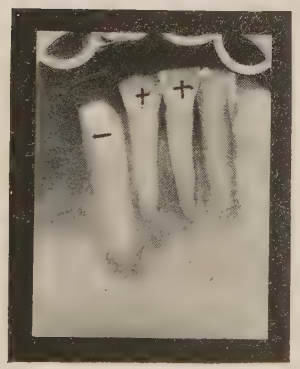

Fig. 48.

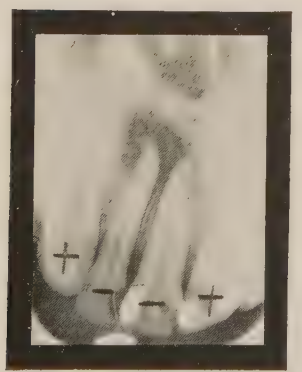

Fig. 49.

Figs. 50 and 51. Fig. 50 is a postoperative radiograph made following the root resection of the upper first bicuspid. The film just takes in the apex of the lateral incisor. It looked "suspicious" and was tested. Result negative (–). Another radiograph (Fig. 51) was made. The slight area of osteoclasia can be seen quite clearly. The pulp of the lateral was dead and the tooth abscessed.

Fig. 52. In this radiograph the upper third molar is missing and the shadow of the malar bone falls over the first molar, the one on the reader's left. There is a very suspicious radiolucent area above the apex of the second molar. But the second molar responds so perfectly to the electric test that we are safe in saying that the pulp is vital and that the radiolucent area is not an abscess.

Fig. 53. We have seen the necessity of checking up x-ray findings with the electric test. Now let me illustrate the necessity of checking up pulp test findings with radiographs. The upper cuspid was quite definitely negative to the strongest current. The radiograph shows the reason for it; the pulp has receded away above the gum line. The pulp is vital but the current could not penetrate the secondary dentin to the pulp.

Fig. 54. The lower cuspid responded positive but *very weak* (+VW). The reason it responds so weakly to the electric test is seen in the radiograph, i.e., the large pulp stone. The first molar is abscessed. Considerable peridontoclasia about the cuspid.

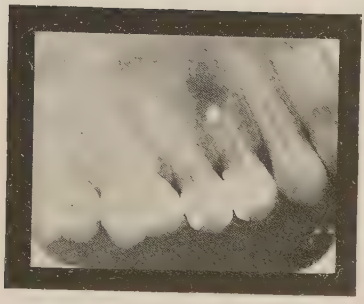

Fig. 50.

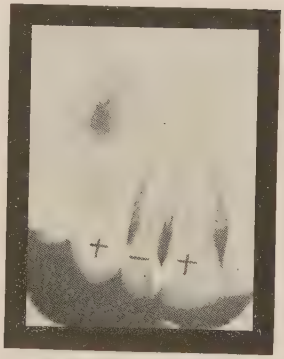

Fig. 51.

Fig. 52.

Fig. 53.

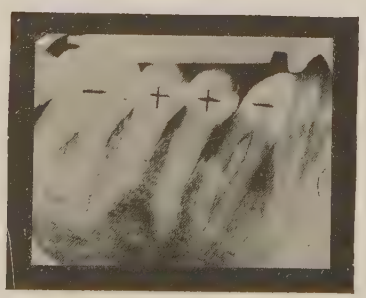

Fig. 54.

Fig. 55. This radiograph illustrates the expediency of the rule to test the teeth on either side of the one suspected of being abscessed. A fistula pointed just to the distal of the apex of the root of the second bicuspid and so it was suspected of being an abscessed tooth. The radiograph shows a definite radiolucent area just to the distal of the apex of the second bicuspid, and involving its apex.

But the results of the application of the test were as follows: Second bicuspid positive (+), first molar positive (+), first bicuspid negative (−). A close study of the radiograph with the tests as a guide resulted in observation of a fistulous tract leading from the first bicuspid to the radiolucent spot in the apical region of the second bicuspid. (Radiograph by Alger of Los Angeles.)

Figs. 56, 57, and 58. Figs. 56 and 57 were made at the same sitting. They show the apex and periapical tissues of the upper lateral incisor at widely different angles. Neither of them show any bone change which might be taken as evidence of a septic pulp in the lateral. The lateral did not respond to the electric test for pulp vitality though, and the operator who referred the case was advised to make a diagnostic opening into the lateral incisor. The operator pinned his faith in the appearance of radiographs and did not make a diagnostic opening.

Fig. 58 was made seven months later. We now see quite definite bone destruction above the apex of the lateral incisor.

Fig. 55.

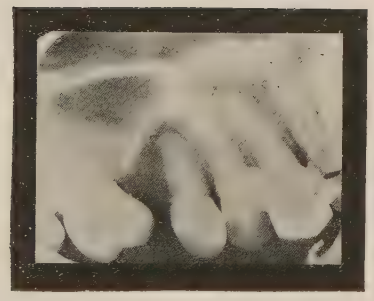

Fig. 56.

Fig. 57.

Fig. 58.

Figs. 59, 60, and 61. These three illustrations have been made experimentally from a skull. Fig. 59 does not show the apical bone destruction, while Figs. 60 and 61, made at different angles, do. Suppose we should have a radiograph of a tooth like the second bicuspid in Fig. 59. There would be nothing in such a radiograph to warn us sufficiently of the necessity of making the radiograph over at different angles, unless we had records of the application of the electric test.

Fig. 62. Another view of the parts in which the angle at which exposure was made was correct. No distortion of the image and the abscess shows.

Figs. 63 and 64. When we have reason to believe a tooth is pulpless, or we know it as we do in the case of the shell crowned upper molar because we can see some canal filling, then we are fully aware of the necessity of getting a good radiographic view of the tooth. But if we have no idea whether the pulp is vital or not then we do not know exactly how thorough our radiographic examination should be. Fig. 63 fails to show the abscess of the upper molar, while Fig. 64, the last one made, shows it, or, to be meticulous, it shows a radiolucent area which I take to be an abscess cavity. It is not infrequently necessary to deliberately distort upper molars in order to cast the shadow of the mesiobuccal or distobuccal roots far enough mesially or distally to observe the tissues at their apices.

Fig. 59.

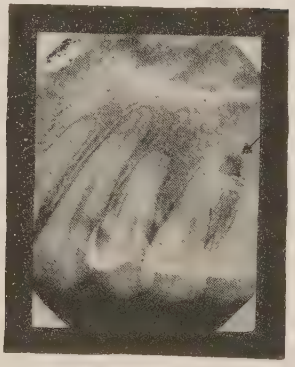

Fig. 60.

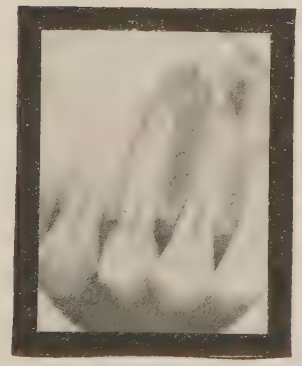

Fig. 61.

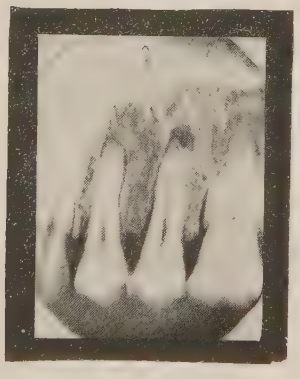

Fig. 62.

Fig. 63.

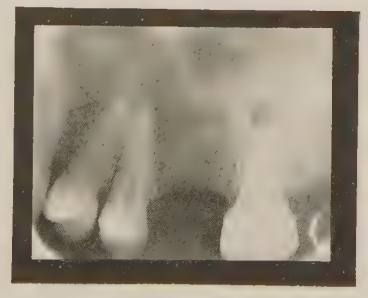

Fig. 64.

Fig. 65. Pericementitis of the second molar. Tooth carries very large amalgam filling. Electric test positive weak (+W). Tooth more tender to pressure to the distal than to mesial or mesio-vertical pressure. The radiograph shows the reason for the pericementitis. The filling in the distal of the second molar and the filling in the mesial of the third molar both hang into the interproximal space causing irritation, inflammation, and osteoclasia.

Fig. 66. The radiolucent spots at the apices of the cuspid and the second bicuspid are of about the same size and almost the same general appearance. The spot at the apex of the second bicuspid I believe to be osteoclasia and odontoclasia, due to infection, in short a spot due to a pathologic process, while the spot at the apex of the cuspid is physiologic; that is to say, it does not represent disease. The fact that the cuspid responds positively (+) to the electric test is very strong, I might almost say conclusive, evidence of the correctness of the opinion regarding the cuspid.

Also there is a small "suspicious spot" in the apical region of the first bicuspid, but the tooth responds positively (+) to the electric test and so I do not look upon this area as a spot of infection.

Fig. 67. The small radiolucent spot at the apex of the root of the second bicuspid might be looked upon as evidence of infection if it were not for the fact that this tooth has a vital pulp, which fact has been established by its very definitely positive (+S) response to the electric test for pulp vitality. A gold shell crown has been removed to test this tooth, a procedure which is not infrequently indicated.

Fig. 65.

Fig. 66.

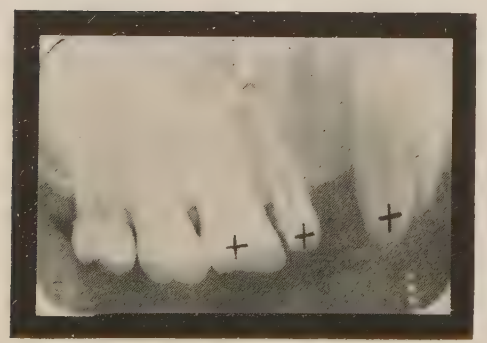

Fig. 67.

Fig. 68. I do not have pulp testing records of this case. Therefore I cannot say whether the small radiolucent areas at the apices of the lower central incisors represent areas of infection or not. The fact that one of them seems to be broken off is contributory evidence of abscess. But, I would not wish to give a *final opinion* without recourse to the electric test for pulp vitality.

Figs. 69 and 70. These two radiographs are of the same case. They are reproduced here (by courtesy of the publishers of my book "Elementary and Dental Radiography") because it was this case which first impressed me with the extreme value of the electric test, and caused me to have test record sheets printed and make it routine practice to apply the test in practically all radiodontic cases.

The following history of the case is quoted from "Elementary and Dental Radiography":

"The end of the root of an upper lateral was resected to cure an abscess. The wound made at the time of operation did not heal normally. A radiograph was made (Fig. 69). It seems to show that the central is involved in the lateral's abscess cavity. The central was tested for vitality of its pulp. It responded to the electric test, indicating a vital pulp. Another radiograph was made, Fig. 70. This second radiograph, made at a different angle, shows no involvement of the central, and what may or may not be an involvement of the cuspid. The shadow passing to the apex of the cuspid does not show clearly. The cuspid was tested and its pulp did not respond to the application of the current. It was opened and found to contain a putrescent pulp. Neither the central incisor, at first suspected, nor the cuspid, finally opened, had carious cavities in their crowns.

Fig. 68.

Fig. 69.

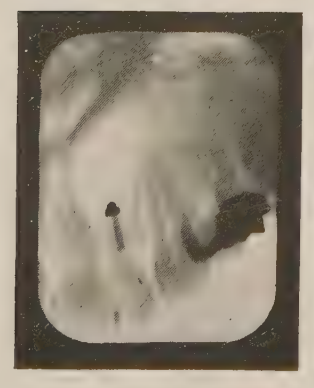

Fig. 70.

Figs. 71 and 72. I do not have the electric test records for this case and I cannot therefore give a reliable interpretation of the radiographs. I see by Fig. 72 that the central incisor has been opened, but whether the operator found a vital or a septic pulp I cannot tell from the radiograph. My guess from observation of Fig. 71 is that the cuspid harbors a vital pulp, but I would not want to give a final opinion without the electric test to help me. (Radiographs by McCormick.)

Fig. 73. The radiolucent area at the apex of the cuspid gives the tooth the appearance of being abscessed, but it is not. It responds positively to the electric test. The abscess arises from the lingual root of the first bicuspid, the crowned tooth.

Fig. 74. The appearance of this radiograph is such as to direct suspicion to the lateral incisor and cuspid. There is considerable bone destruction between these two teeth, and the area of radiolucence extends slightly beyond the apex of the lateral incisor. But both of these teeth—the lateral and cuspid—respond positively (+) to the electric test; so does the central incisor. But the first bicuspid responds negatively (–). The pulp in the first bicuspid was found devitalized and septic. The abscess—i.e., source of bone destruction—was from the lingual root of the first bicuspid.

Figs. 75 and 76. Different views of the same case. Both the lateral incisor and the first bicuspid are involved in a very large abscess. And, certainly, the cuspid has the radiographic appearance of being involved also—but it is not. It responded (+) to the electric test. Subsequent history proved correctness of diagnosis.

It will probably not show in the halftone, but, in the negative, a radiolucent line (the usual line indicating the pericemental membrane) could be seen following the cuspid root. The presence of this line could not be con-

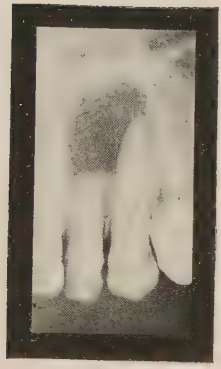

Fig. 71.

Fig. 72.

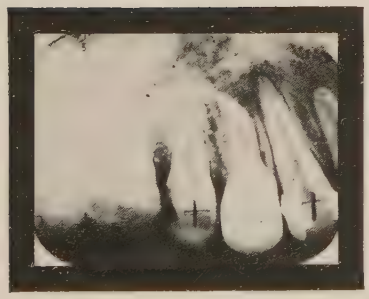

Fig. 73.

Fig. 74.

Fig. 75.

Fig. 76.

sidered proof of the vitality of the tooth, but it was contributory evidence of vitality. Not even the presence of both the radiolucent line, indicating the pericemental membrane, and the radiopaque line, indicating the lamina dura (i.e., the dense layer of bone lining tooth sockets) proves the pulp of the tooth vital and the tooth not abscessed. (See Fig. 59.)

Fig. 77. The radiographic appearance of the lateral incisor in this illustration is quite similar to that of the cuspid in Figs. 75 and 76. Yet, in this case, the lateral is involved in the abscess, while the cuspid, in Figs. 75 and 76, is not. It is the electric test for pulp vitality that gives us the information necessary to the correct interpretation of the radiographs in these cases.

Fig. 78. This illustration is similar in appearance to Figs. 75 and 76. I regret that I cannot locate my records for this case. My recollection is that the cuspid responded positive (+) to the test and was not involved in the large abscess.

Figs. 79, 80, 81, and 82. Showing variation in the location of the mental foramen.

Fig. 79. The mental foramen considerably below the apices of the roots and midway between the first and second bicuspid.

Fig. 80. The mental foramen above the apices of the roots just to the mesial of the second bicuspid.

Fig. 81. The mental foramen at the apex of the root of the second bicuspid. Similar in appearance to an abscess area, but a positive (+) reaction to the electric test eliminates the possibility of abscess.

Fig. 82. The mental foramen at the apex of the first bicuspid. This is a little farther forward than one ordinarily finds the foramen and so the test is particularly needed to make sure that the pulp in the first bicuspid is vital.

Fig. 77.

Fig. 78.

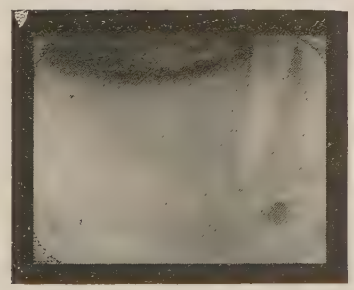

Fig. 79.

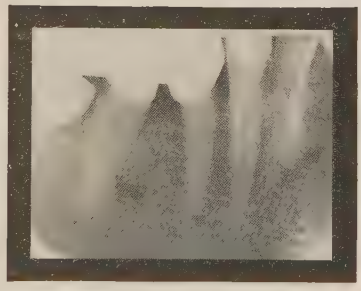

Fig. 80.

Fig. 81.

Fig. 82.

Fig. 83. When in doubt, it is sometimes expedient to make an extraoral radiograph to assist in differentiation between an abscess and the mental foramen. If a spot is seen at the apex of one of the bicuspid teeth and the mental foramen can be seen elsewhere, then the spot at the apex of the tooth must be an abscess—or a large cancellous spot in the bone. And one can get a fair idea as to whether it is a large cancellous spot or not, by the general appearance of the bone, a considerable area of which can be seen in an extraoral radiograph. In this illustration the mental foramen is at the apex of the second bicuspid.

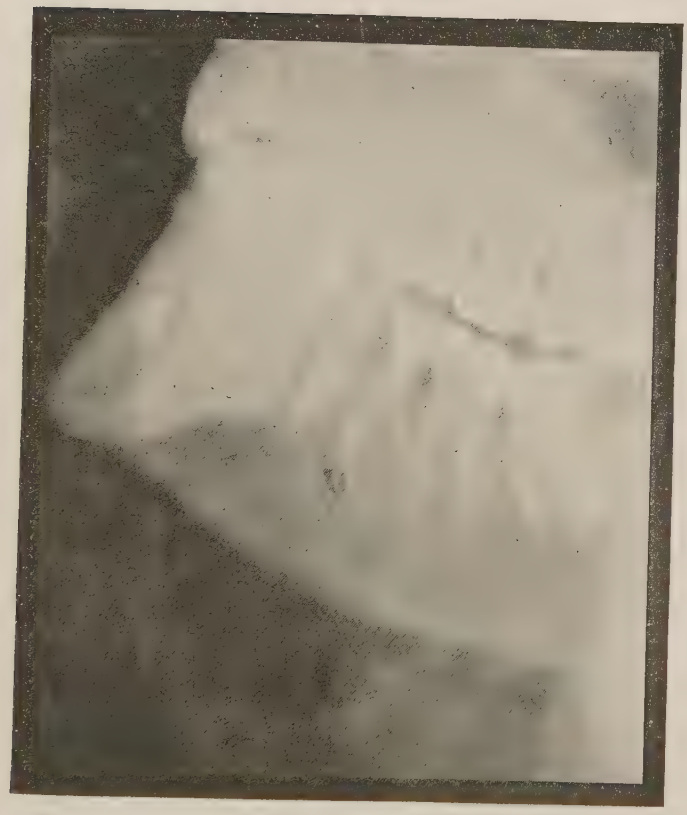

Fig. 83.

Fig. 84. Abscess at apex of first bicuspid. Opinion verified by fact that tooth tests negative (–).

Fig. 85. Abscessed lower bicuspid. The radiolucent area might easily have been mistaken for the mental foramen, particularly because the tooth has no carious cavity in it. Its response to the electric test was negative, however, which led to the correct interpretation of the radiograph.

Fig. 86. That the radiolucent area at the apex of the second bicuspid is of pathologic origin, and not the mental foramen, is indicated rather conclusively by the fact that the tooth responds negative (–) to the electric test. The radiolucent area in this case has more the appearance of an abscess; it is too large for a normal mental foramen. The tooth has no cavity in it.

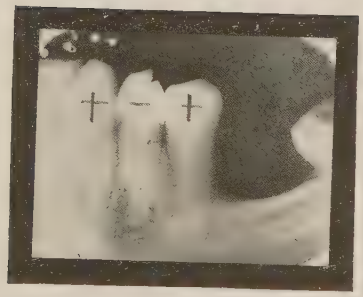

Fig. 84.

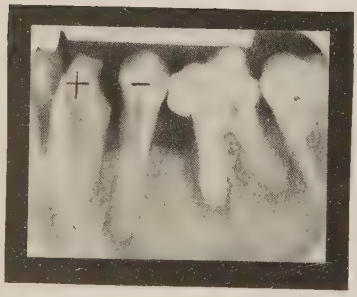

Fig. 85.

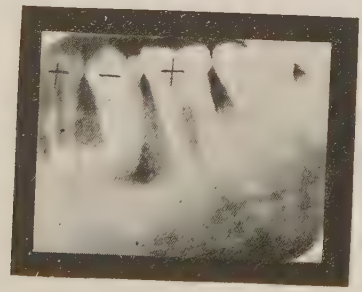

Fig. 86.

Fig. 87. A photograph of a skull showing the anterior palatine foramen, also called the incisive foramen.

Fig. 88. The large radiolucent area and the short root of the central incisor would lead the unwary and the non-user of the electric test to suspect that we have here a dentoalveolar abscess exhibiting considerable tissue destruction both osseous and dental. The facts are that the radiolucent area is the anterior palatine foramen and the root of the tooth is malformed and short, not absorbed.

The radiograph is of the dry specimen shown in Fig. 87, in which the shadow of the anterior palatine foramen has deliberately been cast at the apex of one of the central incisors giving it (the foramen) the appearance of an abscess area. In order to cast the shadow of the foramen at the apex of the central incisor tooth, the horizontal angle of the x-ray was somewhat as indicated in Fig. 87 by arrow No 1.

Fig. 89. Another radiograph of Fig. 87, which like Fig. 88, shows the anterior palatine foramen at the apex of the central incisor.

Figs. 90 and 91. Two radiographs made at different angles from Figs. 88 and 89, in which the shadow of the anterior palatine foramen is cast between the roots of the central incisors instead of at the apex of one of them. The horizontal angle to make these radiographs was more like No. 2 than arrow No. 1 of Fig. 87.

The combination of central and lateral incisors on one intraoral radiograph is a good combination to get a good view of the parts, but the operator should be rather careful to have his horizontal angle as indicated by arrow No. 2 and not as indicated by arrow No. 1 else the anterior palatine foramen may be mistaken for an abscess. This is especially true when the central incisors are known to be pulpless.

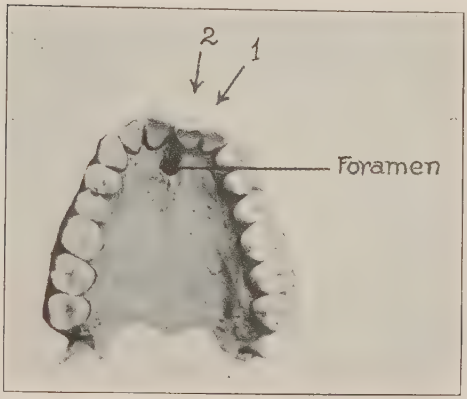

Fig. 87.

Fig. 88.

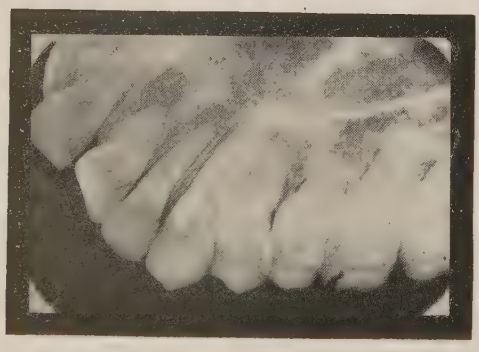

Fig. 89.

Fig. 90.

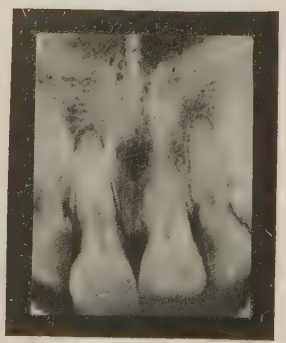

Fig. 91.

Figs. 92 and 93. In Fig. 92 a radiolucent area is seen at the apex of the central incisor, with the large inlay in it, having the appearance of an abscess. The tooth responds positively (+) to the electric test, however, which indicates that the pulp of the central is vital and therefore that the radiolucent spot at its apex is the incisive foramen and not an abscess cavity. . .

Fig. 93 is another radiograph of the same case as Fig. 92, made at a different angle. The shadow of the anterior palatine foramen is no longer seen at the apex of the central incisor with the large inlay. It can be seen faintly between the apices of the central incisors.

Figs. 94 and 95. Two radiographs of the same case which, like Figs. 92 and 93, show the anterior palatine foramen at the apex of a central incisor from one view (Fig. 94) and between the apices of the roots of the incisors from another view (Fig. 95).

Fig. 96. A colleague sends me this radiograph and assures me that there are no symptoms or signs of cyst and that the pulp of the central incisor is vital. Accepting this information as true, I should say we have here a very large and most unusual-appearing anterior palatine foramen.

Fig. 97. Another anterior palatine foramen of somewhat unusual appearance.

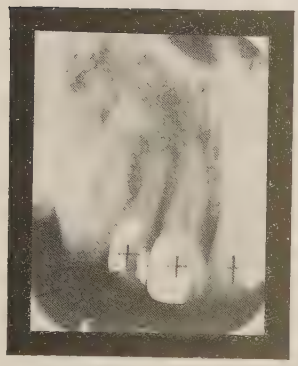

Fig. 92.

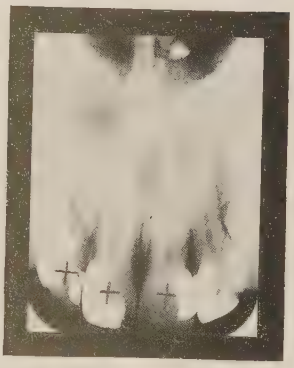

Fig. 93.

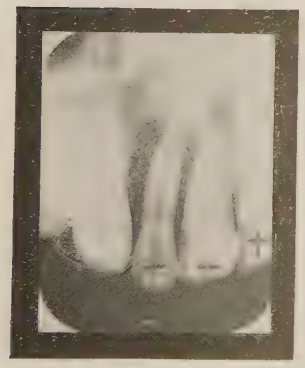

Fig. 94.

Fig. 95.

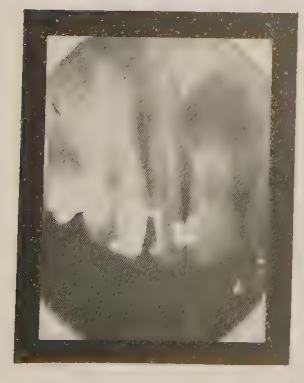

Fig. 96.

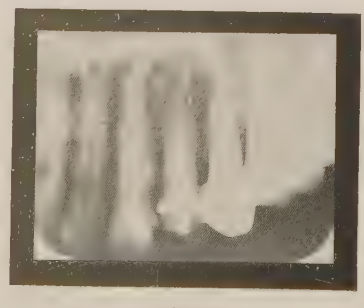

Fig. 97.

Figs. 98 and 99. Dr. Mathew Cryer, long before the use of x-rays became popular, wrote a genuine masterpiece of a book entitled "Internal Anatomy of the Face." It was this little book that first taught us of the tremendous variability of the antrum of Highmore in size, shape, and location. The use of radiographs have fully borne out Dr. Cryer's teaching.

Figs. 98 and 99 are the right and left side of the same case and show a very large antrum of Highmore. In cases such as this it is a relief to be able to test the teeth with the electric test and find them vital. It verifies one's opinion. In this particular case the crowned teeth could not be tested, but all the other teeth were tested and responded (+). Compare Figs. 98 and 99 with Fig. 126.

Figs. 100 and 101. Two radiographs of the same case, made at slightly different angles. Compare the antrum in this case to the ones shown in Figs. 98 and 99.

This one has very much the appearance of an abscess cavity arising from the second bicuspid or first molar. Both bicuspids and both molars test positively (+) however. The second molar responds positive strong (+S). The reason for it is the carious cavity in the distal surface.

Figs. 102 and 103. Two cases in which the first molars responded negative (–) to the electric test. Both had septic pulps. Fig. 102 shows evidence of cyst formation. The radiographic evidence of infection in these cases might easily have been overlooked—i.e., mistaken for antrum shadows—had it not been for the electric test which directed especial attention to them.

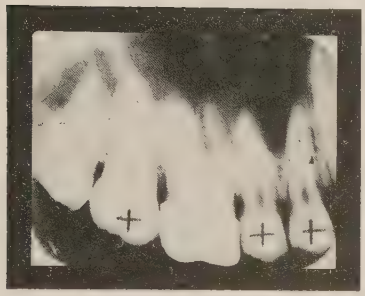

Fig. 98.

Fig. 99.

Fig. 100.

Fig. 101.

Fig. 102.

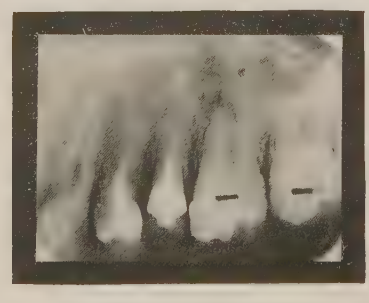

Fig. 103.

Figs. 104 and 105. The two sides of the same case showing antra of more or less typical appearance.

Figs. 106 and 107. Fig. 106 exhibits a shadow over the cuspid and first bicuspid which might, from the radiographic appearance, be mistaken for an abscess or cyst. Both the first bicuspid and the cuspid respond positive (+) to the electric test. The shadow at their apices is the maxillary sinus. Fig. 107 is another case in which the antrum is seen so far forward it overlaps (in the radiograph) the end of the root of the cuspid.

Figs. 108 and 109. Right and left sides of the same case. Another case in which the shadow of the antrum comes rather far forward. The radiopaque lines indicating the walls—i.e., the dense cortical bone—surrounding the antrum can be seen rather clearly in this case. The opinion that the large radiolucent areas are the maxillary sinuses is strengthened by the results of the application of the electric test. All teeth test positive (+), except the lateral incisors. The dark area in the region of the left lateral (Fig. 108) is of infectious origin.

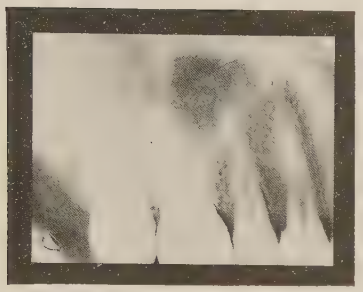

Fig. 104.

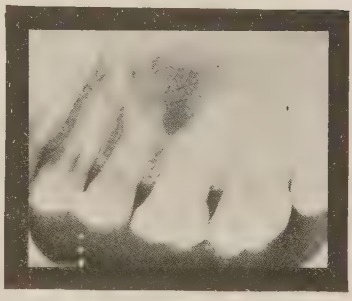

Fig. 105.

Fig. 106.

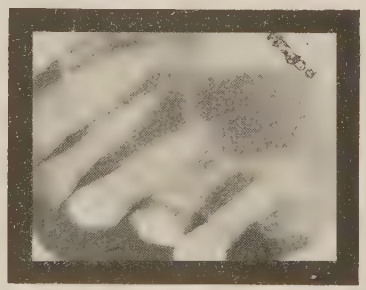

Fig. 107.

Fig. 108.

Fig. 109.

Fig. 110. This radiograph illustrates a rather typical appearance of radiolucency in the apical region of the upper lateral incisor, due to the canine or incisal fossæ, a depression just mesially to the canine eminence.

In passing, note the recession of the pulp—the throwing up of secondary dentin as it retreats—caused by the carious cavity in the tooth.

Figs. 111 and 112. In this case the radiolucency in the apical region of the lateral incisor is too pronounced to be considered physiologic. Yet the lateral responds positive (+) to the electric test. So do the approximating central incisor and cuspid. The cause of the radiolucency, in the region of the apex of the lateral, which by the way can be seen extending over toward the cuspid, arises from the badly diseased first bicuspid.

Fig. 113. Radiolucency in the apical area of the lateral on the reader's left. Tooth negative (–) to electric test. Tooth abscessed. The radiolucent area due to the abscess and the nasal fossa spot on that side merge into one another.

Figs. 114 and 115. The fossæ spots can usually, but not always, be seen in radiographs of the upper incisor teeth. Other things being equal, the higher the angle of the x-rays at the time of exposure, the lower down—i.e., closer to the apices of the roots of the upper incisor teeth—fall the shadows of the nasal fossæ.

The nasal fossæ spots in Fig. 114 are removed a considerable distance from the apices of the roots of the incisor teeth, while in Fig. 115 the nasal fossæ spots are just above the apices of the incisors. This difference is due partly to differences in the cases and partly to differences in the angle. Fig. 114 is more typical in appearance than Fig. 115.

Fig. 110.

Fig. 111.

Fig. 112.

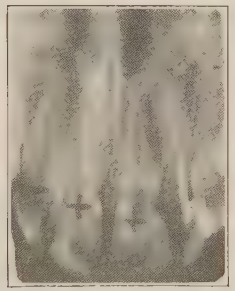

Fig. 113.

Fig. 114.

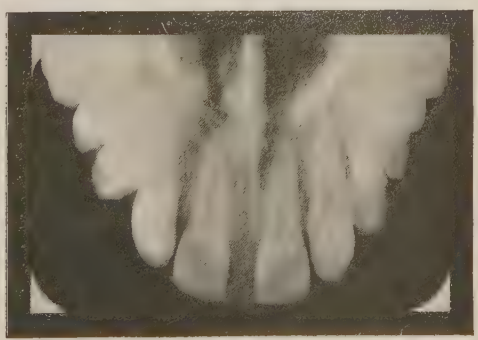

Fig. 115.

Fig. 116. Another case in which the nasal fossæ spots are rather low down and in which the shadow of the abscess of the central incisor, on the reader's left merges into the shadow of the nasal fossæ.

Fig. 117. The disto-buccal root of the upper first molar seems to be absorbed but the tooth is vital—responds positive (+) to the electric test—and very often the disto-buccal roots of upper molars are not bulky enough to register in radiographs clearly.

The spot at the apex of the first bicuspid is of about the same size and appearance as the spot at the apex of the second. However, the first bicuspid responds positive (+) to the electric test. Therefore the spot at its apex cannot be osteoclasia due to infection.

Figs. 118 and 119. The same radiograph developed to different degrees of intensity in an effort to show both the roots and the pulp chamber without retouching, or at least with the minimum of retouching.

The disto-buccal root of the first molar seems to be absorbed. But we have learned this may be physiologic.

How about this though? The tooth responds hardly at all (+VW) to the electric test!

The pulp of the tooth is vital. The reason it does not respond better to the electric test is disclosed by a study of the shape of the pulp chamber. The presence of the large metal restoration in the crown has caused recession of the pulp and development of secondary dentin. The distal half of the pulp chamber is obliterated.

Fig. 116.

Fig. 117.

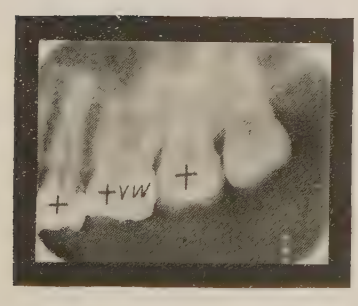

Fig. 118.

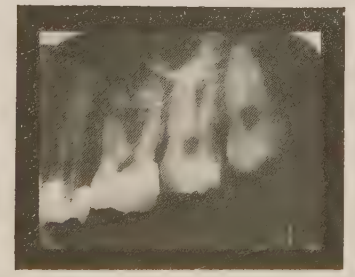

Fig. 119.

Figs. 120 and 121. Radiographs of the same case made at different angles. Fig. 120 was made with the x-rays passing straight through the teeth from facial to lingual. Fig. 121 was made with the x-rays passing diagonally through the teeth from facial to lingual. Note how indistinct the root outlines are in Fig. 121. I have seen this indistinctness of root outline due to angle mistaken for absorption of the root due to disease. The roots particularly susceptible to this sort of distortion are: (1) Upper bicuspids (2) Lower molars (3) Mesio-buccal roots of upper molars.

Where the electric test can be applied satisfactorily and a positive reaction is obtained, the appearance of root roughness due to angle cannot be mistaken for absorption of the root. There is a radiolucent area in the mesial surface of the first bicuspid which has the appearance of a carious cavity; it is the interproximal space.

Figs. 122 and 123. Two radiographs of the same case made at different angles. See how distinct the outlines of the roots of the molar are in one view and how indistinct they are in the other.

Fig. 124. The radiolucent spots at the apices of the roots of the third molar (the first molar is missing) look very suspicious and they cannot be cast away from the ends of the roots by changing angle. They are *at* the apices of the roots. The electric test is definitely positive (+). The reason for the small radiolucent areas is that the roots of the teeth are not quite fully formed. Note the funnel shaped open end of the root. (Radiograph by Eller, Albuquerque.)

Fig. 125. Same case as Fig. 124, other side of the mouth.

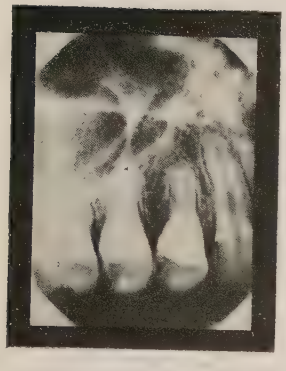

Fig. 120.

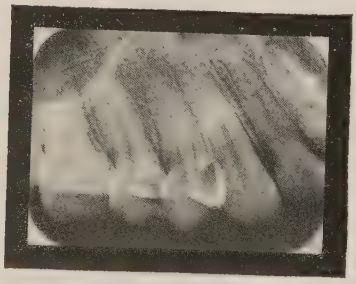

Fig. 121.

Fig. 122.

Fig. 123.

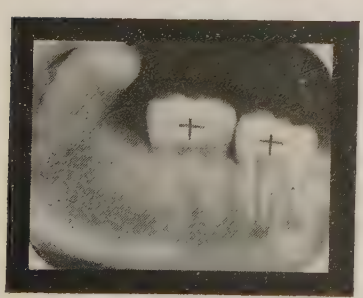

Fig. 124.

Fig. 125.

Fig. 126. The abscess illustrated here is larger than an antrum. Obviously the first bicuspid is pulpless for we see canal filling in the canals. The roots of the cuspid and second bicuspid seem to have their apices absorbed. These teeth gave a negative (–) reaction to the electric test for pulp vitality. After extraction it could be seen that these root ends had been destroyed just as they appear to be in the radiograph. The crown was removed from the lateral incisor and the electric test applied. It was negative (–). This tooth also was involved in the abscess. The central incisor, which does not show in the negative, also was involved as seen in another negative not reproduced here.

The electric test is of extreme value in checking up such unusual findings as these.

Fig. 127. How many teeth are involved in the abscess illustrated here? Frankly I cannot tell. I am reasonably sure the central incisor, with the canal filling, is involved because I know it is pulpless and because its apex is about in the mesio-distal center of the diseased area. But are the two approximating teeth involved? That is the question. And, in the absence of electric test records, I cannot answer it.

Fig. 126.

Fig. 127.

Figs. 128 and 129. Two radiographs from different angles, another case in which I do not have electric test records. Therefore I do not know whether the lateral incisor is involved in the abscess or not. I think it is, but I would depend on the electric test to verify this opinion. If the tooth has a vital pulp it is not abscessed. If it does not have a vital pulp, it very likely is abscessed.

It is interesting to know that this case was brought to the writer's attention as an example of failure of the root end resection operation to cure a focus of infection—in short as an argument against root resection. It seems to me to be a mighty poor argument against root resection. No wonder we have failure in this case. The cuspid is pulpless and infected, the central also and perhaps the lateral incisor. The operator resected only the buccal root of the first bicuspid. The lingual root, with a very imperfect canal filling in it, remains untouched as can be seen in Fig. 128. The stub of the buccal root is not patched with amalgam. It is not good judgment to draw one's opinion of the possibilities of the root resection operation from cases like this.

Fig. 130. Symptoms those of semiacute dentoalveolar abscess with sinus discharging pus in apical region between central and lateral incisors. The radiograph shows bone destruction along the sides of the roots between the central and lateral incisors near the apices but without definitely involving the apices. Response to electric test a definite positive (+). Conclusion: One of those comparatively rare cases of "pyorrhea" where, instead of the pus discharging about the neck of the tooth it discharges like a dentoalveolar abscess through the external alveolar plate.

The treatment indicated for pyorrhea is vastly different from that indicated for a dentoalveolar abscess. Hence the necessity of correct diagnosis. This case was treated in accord with the diagnosis given above and yielded to the treatment.

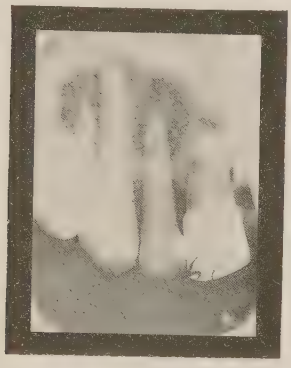

Fig. 128.

Fig. 129.

Fig. 130.

Fig. 131. Another case in which pyorrhea had the symptomatic appearance of a dentoalveolar abscess. But the electric test and the radiograph combined to make a correct diagnosis.

The writer has encountered a few cases similar to Figs. 130 and 131, in which the trouble was caused by a silk ligature, or a ring of rubber dam, left on the tooth. The ligature, or rubber ring jerked out of the rubber dam when removed carelessly and hastily, particularly the latter, works beneath the gum toward the root end causing a great deal of inflammation and loosening of the tooth or teeth. The electric test is very valuable in such cases as the symptoms simulate abscess very closely. Orthodontic elastics encircling one or more teeth have been known to escape under the gum and cause the same trouble ascribed to ligatures and rings of rubber dam.

Fig. 132. The third molar responded positive very strong (+VS) to the electric test. The reason is the large carious cavity in the mesial surface. The outlines of the roots are indistinct, not due to angle but to hypercementosis. Hypercementosis occurs much more frequently in pulpless teeth than in teeth with vital pulps.

Fig. 133. There is a radiolucent spot at the bifurcation of the roots of the lower first molar. The tooth is negative (–) to the electric test. The tooth is abscessed, though there is no radiographic evidence of it at the apices of the roots. The dark area at the bifurcation is caused by a perforation of external alveolar plate, i.e., a hole in the external alveolar plate. This perforation of the external plate of bone on a level with the bifurcation of the roots is due to the thickness of the oblique ridges. If, my reader, you are inclined to incredulity, let me say I have a dry specimen closely analogous to Fig. 133.

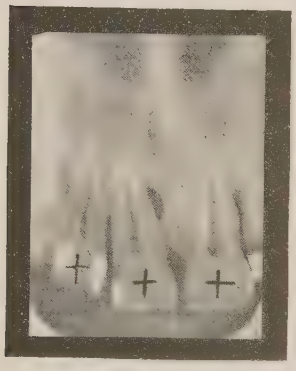

Fig. 131.

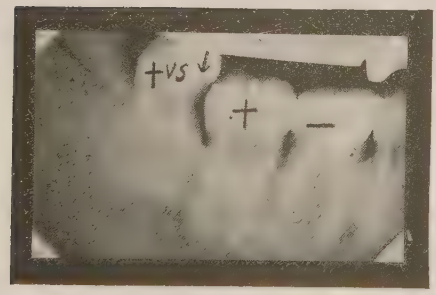

Fig. 132.

Fig. 133.

Fig. 134. Note the radiolucent area just above the bifurcation of the roots of the second molar. Tooth responds positive strong (+S) to the electric test. The radiolucent area is a large carious cavity beneath the gum line on the buccal.

Fig. 135. The oblique ridges cast a sort of haze over the apical region of lower molars in some cases, so that the operator may overlook an area of radiolucency if he is not careful. Seeing an abscess area through the oblique ridges is rather similar to observing something through a fog. When a lower molar is known to be, or thought to be, without a vital pulp, one is more careful in one's examination of the periapical tissues. Hence the value of the test to determine pulp vitality.

Fig. 135 is overdeveloped and published without retouching. It shows the haze of radiopacity cast by the oblique ridges. In the negative now before me, I can see a radiolucent abscess area, through the haze of the ridges, at the apex of the molar tooth.

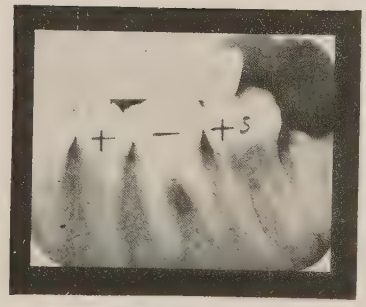

Fig. 134.

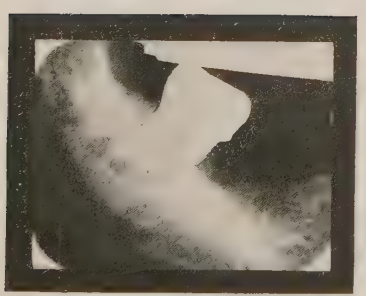

Fig. 135.

Conclusion

My objective in this chapter has been to prove the electric test *necessary* to the correct and reliable interpretation of radiographs and therefore necessary to the art of dental diagnoses. I could go on indefinitely citing case after case, just as one could go on indefinitely citing case after case to prove the usefulness of the radiograph in the practice of dentistry, but it is not necessary. *I believe* I have attained my objective. I believe I have proved the value of the test and so I submit no further evidence but "let my case rest with the jury."

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